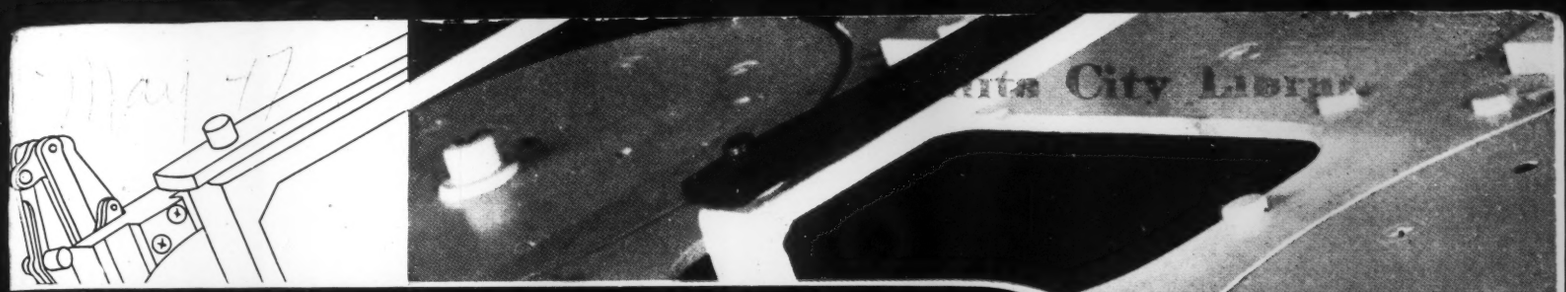
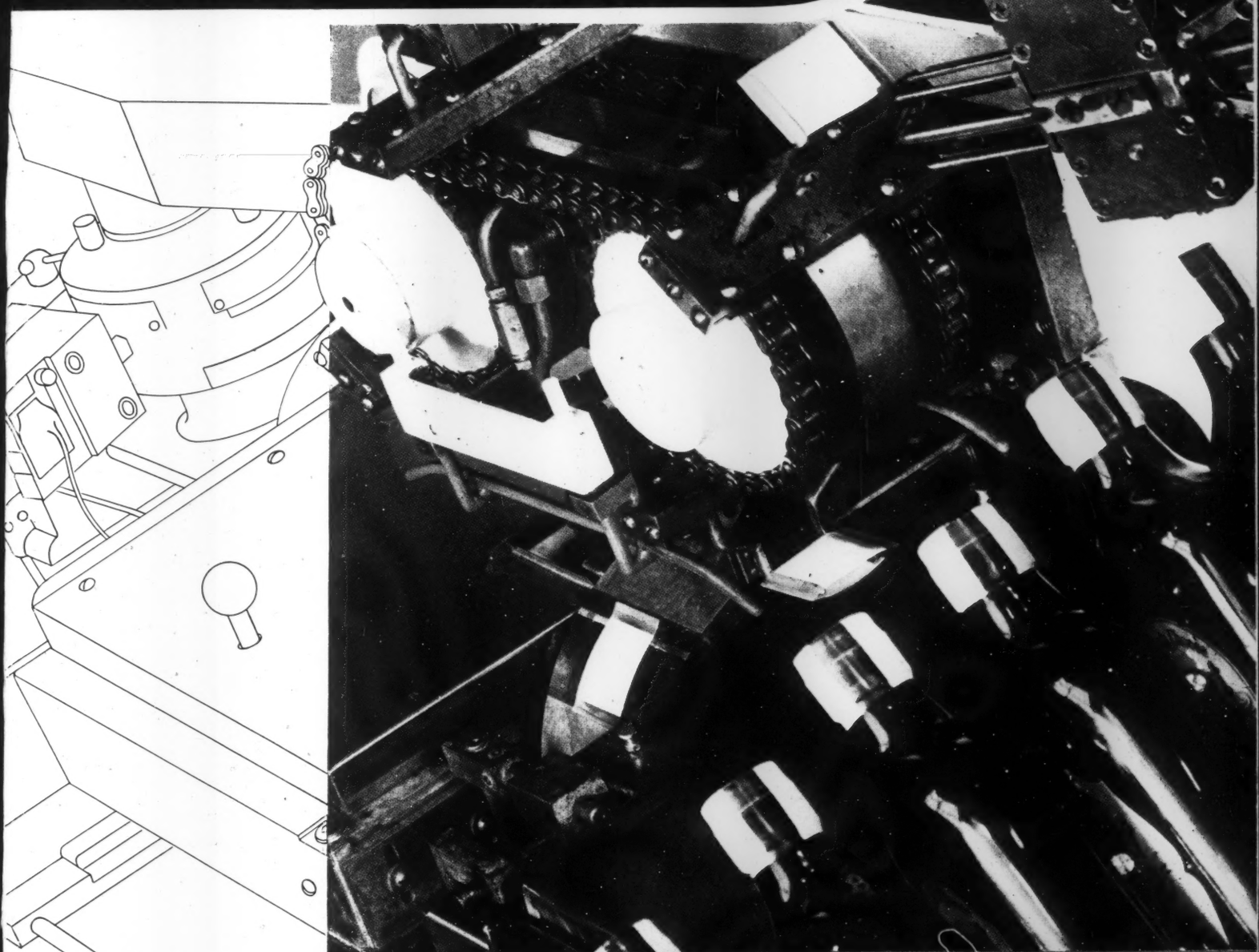


MACHINE DESIGN

May *1947*



In This Issue: AUTOMATIC SEALING MECHANISM
PNEUMATICS IN DESIGN . . BARREL-TUMBLING FINISHES

One of a Kind

Powerful *Texrope* drive specially engineered for a large mill. This main driver sheave is 7 ft in diameter, has 30 grooves, transmits 1400 hp!

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EVERY TEXROPE DRIVE IS ENGINEERED FOR ITS JOB

YOU GET sound recommendations from Allis-Chalmers — recommendations backed by the greatest V-belt engineering talent and experience in the business.

Allis-Chalmers originated the Multiple V-belt drive 22 years ago. Since then, *Texrope* engineers have designed many thousands of drives, ranging from fractional horsepower units for manufacturers of small compressors, pumps or washing machines—to the largest V-belt drives ever installed. They've served: Textile, Mining, Metal working, Petroleum, Chemical . . . in fact, *every* major industry.

Take advantage of this vast research and experience. Bring your V-belt problems to headquarters — for the best in engineering talent — for the most complete line of V-belt equipment made.

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TEXROPE .. Greatest Name in V-Belt Drives

"Super 7" V-BELTS
Five Types — Sizes to suit every power transmission job.

Texsteel, Texdrive, "Magic-Grip"
— sheaves in a full range of sizes, grooves.

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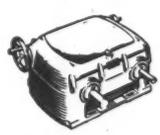
Exact variations in speed, stationary or motion control.



SPEED CHANGERS
Speed variations up to 375% at the turn of a crank.

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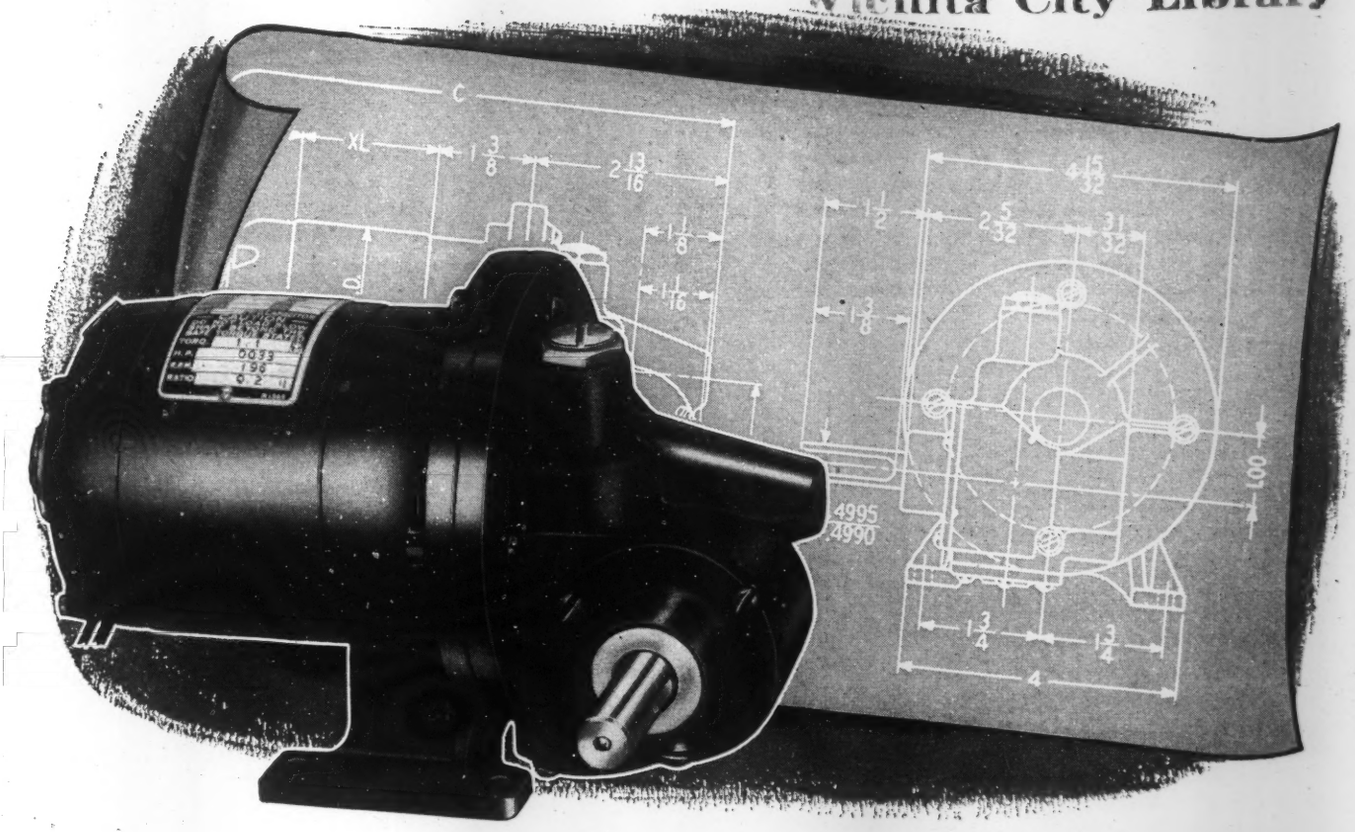


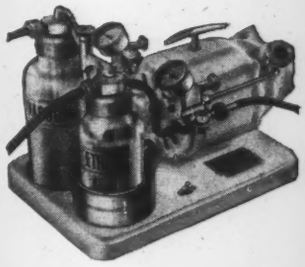
THE RIGHT MOTOR FOR YOUR NEEDS

No matter what your design application, the motor selected must be chosen to meet the operating requirements peculiar to the application. Therefore, full consideration should be given to the motor during the design of the product which it is to operate. Space requirements of the properly chosen motor can then be anticipated in the final design.

Designers of all types of equipment have long relied on Bodine motors where only fractional horsepower is needed but where reliability is of extreme importance. Many Bodine motors have been chosen for applications where maintenance attention is either infrequent or completely lacking, since they have proved their ability to operate for long periods of time without failure.

Bodine fractional horsepower motors, either with or without reducers, provide long, dependable service because they are carefully constructed to precision standards. If you have a design problem involving fractional horsepower motor drive, ask Bodine engineers for their suggestions. Bodine Electric Company, 2258 W. Ohio St., Chicago 12, Illinois.

TYPICAL APPLICATION



SUCTION AND ETHER PUMP

Operation of Gomco suction and ether pumps is an example of the choice of Bodine motors for applications requiring absolute dependability in service. These anaesthetic pumps must provide unfailing performance during surgery. The use of Bodine motors in both the small, portable units and the larger cabinet models is an indication of their proved reliability.

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OIL SEALS *Engineered* TO THE REQUIREMENTS OF YOUR NEW PRODUCT

In serving industry over a period of years, sealing problems of all types have been encountered and solved. The many installations cover a wide range of shaft speeds, lubricant pressures, operating temperatures and the presence of grit, moisture or corrosive agents. Each problem has contributed to broadening the range of application of "Perfect" Oil Seals.

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Regardless of how much experimenting you may find necessary with other phases of your new product design, there need be none concerning the sealing of shafts. Ask Chicago Rawhide Engineers for their recommendations.

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THIS MONTH'S COVER: Automatic sealing machine designed by Gisholt Machine Co. employs pneumatics in pick-up drum and two chain transfers with expandable fingers so that containers may travel at high speed on straight conveyor. Design features of this machine are discussed in the article beginning on Page 87.

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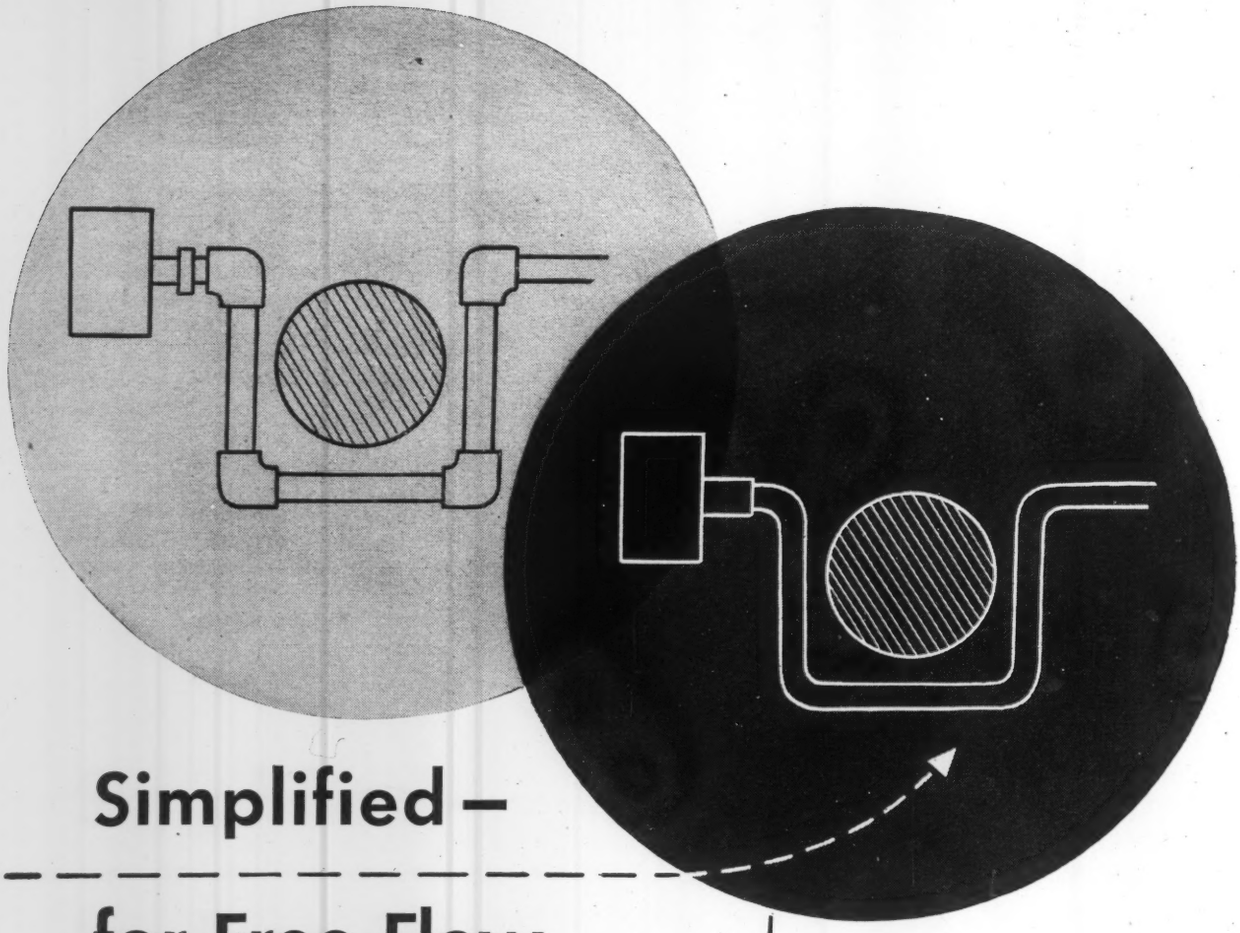

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Easy to bend, tubing goes wherever you want it—around corners—into tight places . . . with *fewer fittings*—fewer chances for leakage. Assembly and maintenance are quicker—easier.

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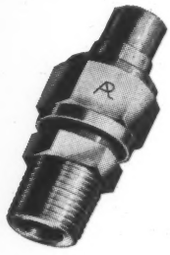

THIS PARKER TUBE FITTING MAKES FREE-FLOW SYSTEMS POSSIBLE

With this Tube Fitting—as with all PARKER Fittings and Valves—pressure-tight and leakproof connections are assured.

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All PARKER Fittings are ***precision-made***—easy to install or remove, and every PARKER Fitting is a *coupling*.

Write for Bulletin A-48, reviewing PARKER Products.

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4 Rapid reversal where wanted without stopping motor.
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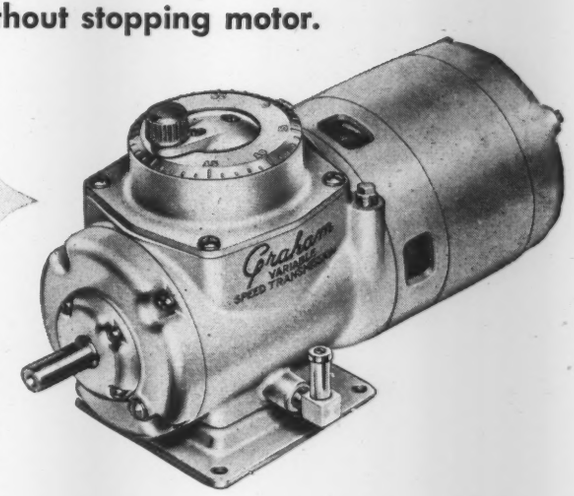

★ ONLY **Graham** gives you all 6 features—in a variable speed drive

★ at a price that keeps your machine competitive!

Now the machine you build can have all the advantages of a full speed range — from top to zero (plus reverse where wanted)—and still be sold competitively. Graham prices have been reduced more than half by simplified design and volume-production economies. Some models are priced as low as $50 (without motor.) That means you can apply the full advantages of Graham variable speed drive to low-power machines such as small tools, office machines, pumps, cutting torches, etc. — *and still remain competitive as to price!*

Graham is the only variable speed drive built as a straight line extension of a standard induction motor. It is a model of compactness, requiring no more fastenings than a single-speed motor. Model 40 (for ¼ to ¾ HP motors) and Model 15 (up to ⅛ HP) are available with or without motors — see tables below — or with built-in parallel shaft or right-angle gear units, reductions, or step-ups; with speeds down to zero and a moderate reverse, or equal speeds both sides of zero. Wide choice of controls; direct or remote, includes: manual, micrometer, lever, switch, or selsyn types, or combinations according to requirements.

Graham performance is proved by 8 years of success as standard equipment on leading machines. For complete information, write us for Bulletin 509, with prices and delivery.

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For Coupled Motor or Offset Drive.

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***With built-in motor.** Note that the built-in motor is especially designed to form an integral streamlined part of the drive.*

•

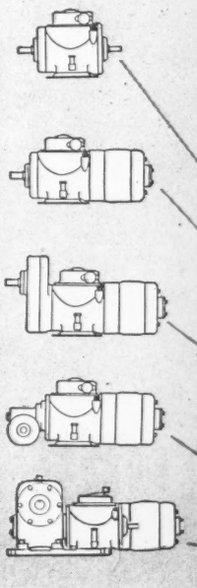
With built-in motor and built-in spur reduction or step-up.

•

***With built-in motor and built-in worm reduction, Model 15.** Output shaft may extend horizontally to either side, or vertically up or down. Additional ratios available—6:1, 10:1, 15:1, 30:1, and 60:1.*

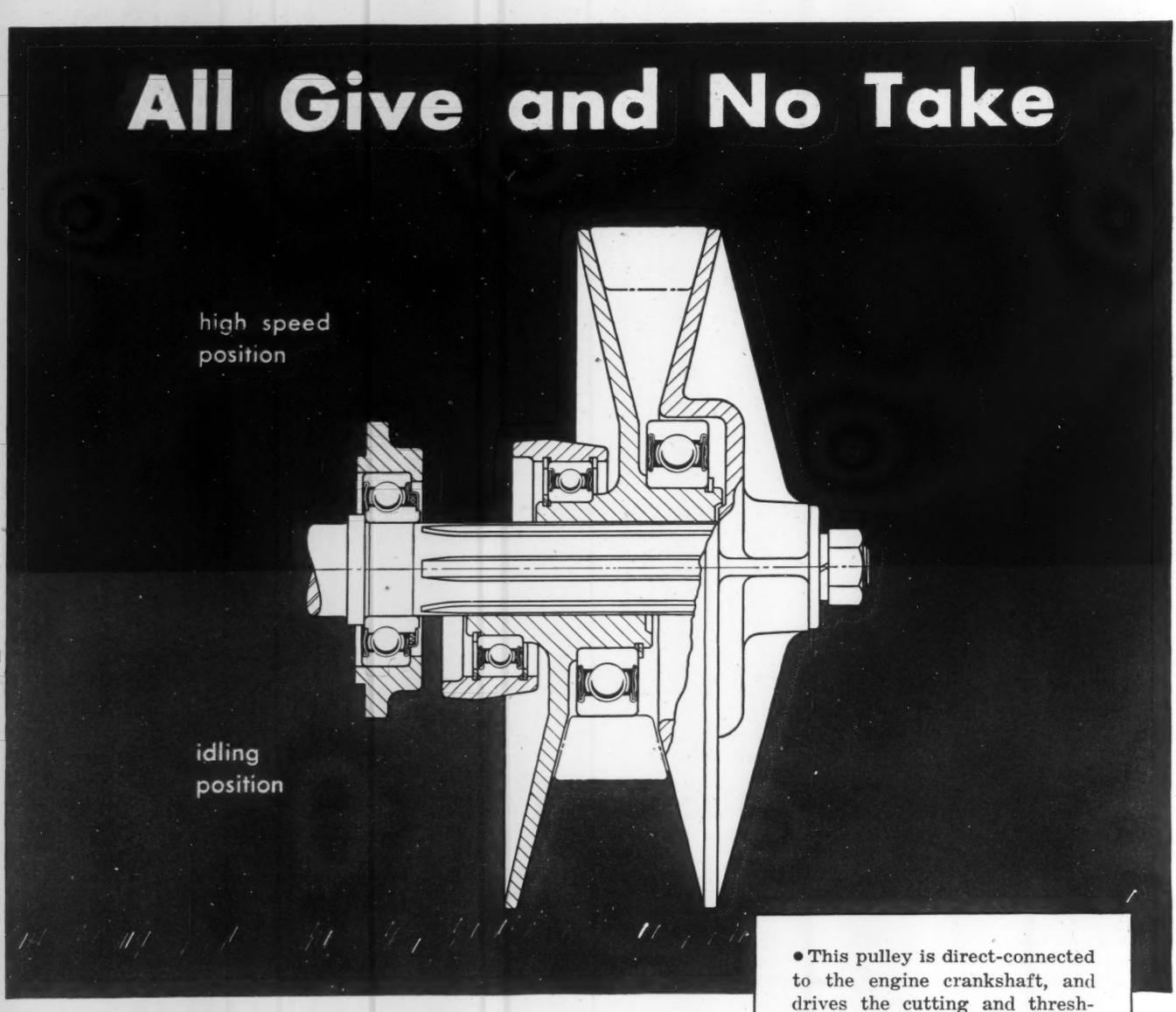
•

***With built-in motor and built-in worm reduction, Model 40.** Output shaft extends both sides horizontally or vertically up or down. Additional ratios available — 9:1, 12:1, 18:1, 36:1 and 47:1.*



Model	Input Speed	Output Speed Range	In Lbs. Torque Rating		Approx. Ins. Overall Dimensions			Motor H.P.
			At Max. Speed	At Min. Speed	Lgth. incl. shaft ext.	Width	Height	
15	3600	1100/0	3.5	7.5	8¼	4⅝	5⅜	1/15 to ⅛
40	3600	1100/0	30	60	14½	7	8	¼ to ¾
15M	3600	1100/0	3.5	7.5	11½	4⅝	5⅜	1/15 to ⅛
40M	3600	1100/0	30	60	19½	7	8	¼ to ¾
15MR5	3600	220/0	15	35	13	4⅝	6¾	1/15 to ⅛
40MR5	3600	220/0	140	280	22	7	10	¼ to ¾
40MR2.8	3600	400/0	80	160	22	7	10	¼ to ¾
15MS2.5	3600	2750/0	1.3	2.8	13	4⅝	6¾	1/15 to ⅛
40MS2.8	3600	3100/0	10	20	22	7	10	¼ to ¾
15MW20	3600	55/0	35	75	12¾	4⅝	5⅜	1/15 to ⅛
15MW40	3600	28/0	60	120	12¾	4⅝	5⅜	1/15 to ⅛
40MW6	3600	190/0	120	250	24	8½	10½	¼ to ¾
40MW24	3600	46/0	420	840	24	8½	10½	¼ to ¾
40MW60	3600	19/0	800	1700	24	8½	10½	¼ to ¾

All Give and No Take



• This pulley is direct-connected to the engine crankshaft, and drives the cutting and threshing units of a self-propelled combine. It not only operates as a variable speed pulley, but as a clutch as well.

When the pulley is wide open, the belt is supported by a self-sealed ball bearing whose inner race revolves with the shaft. As it is closed, the pulley starts the drive from the lowest speed position.

IT is mighty difficult to match the versatility of ball bearings — their ability to *give* so many advantages, yet require so little or nothing in return.

As in this variable speed drive and clutch, they can be self-sealed and lubricated for years of carefree operation.

Here they give permanent axial and radial location of all parts — complete freedom from lubricating care — freedom from adjustments — freedom from grease plugs or nipples, from separate seals or closures.

That is a lot of *give* to both machine builder and user that can be chalked up on the profit side.

Nothing Rolls Like a Ball

NEW DEPARTURE
BALL BEARINGS

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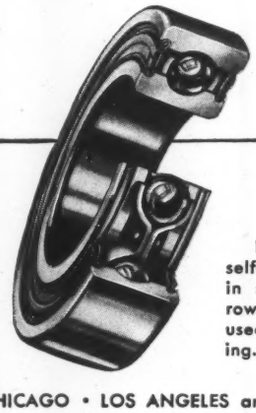

New Departure self-sealed bearing in standard single row dimensions as used in this mounting.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN. • Branches in DETROIT • CHICAGO • LOS ANGELES and other cities

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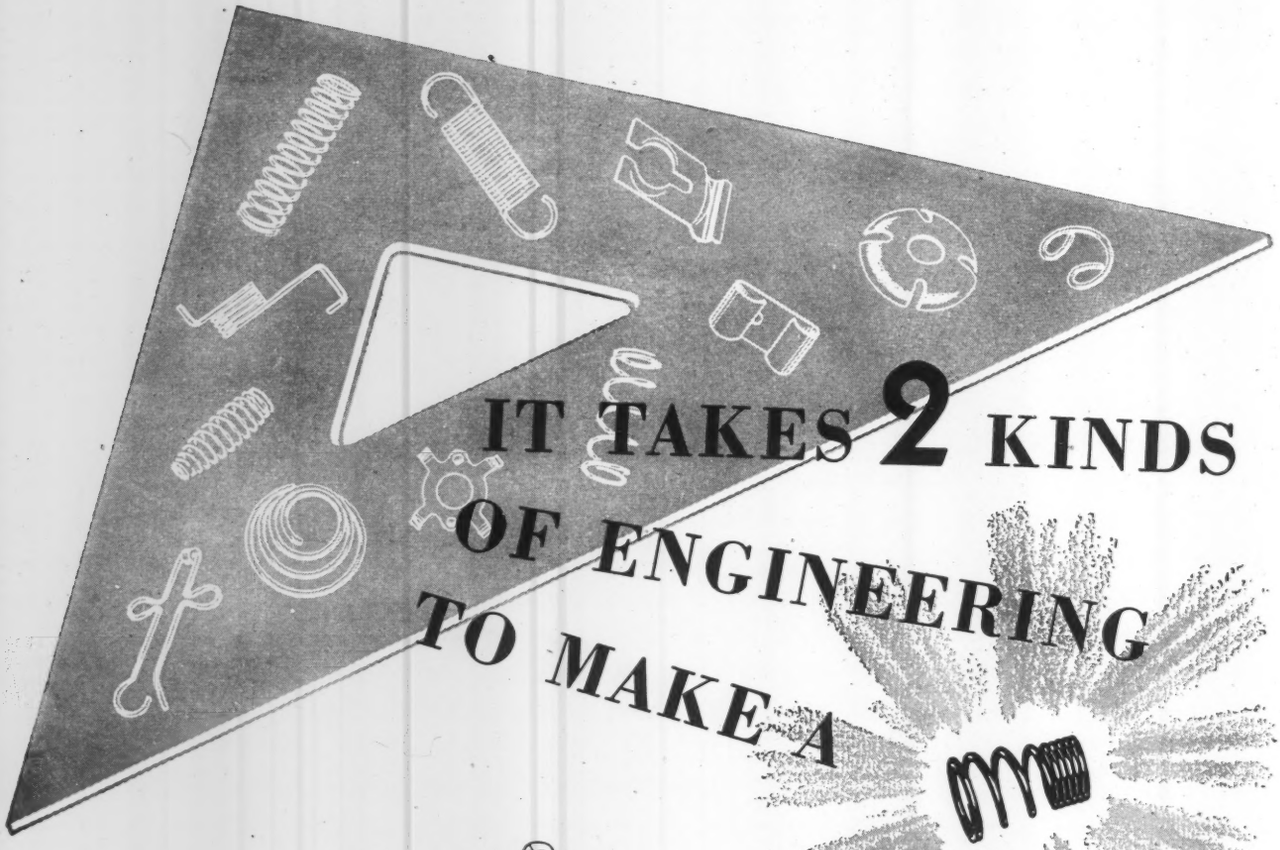
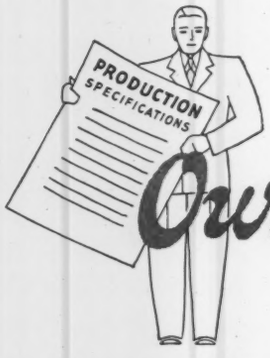


IT TAKES 2 KINDS OF ENGINEERING TO MAKE A

Yours



Ours

When your spring specifications call for extra close limits, accuracy at different load tests, tricky bends or end treatment—it's no simple matter to meet them—without costly second operations—*unless* . . . . .

. . . . *someone gives those specifications a good going over for production problems.* Here at Wallace Barnes are men who know how to utilize machinery, materials and methods to get the results you want, in the fewest operations. This knowledge, applied *in the early stages of your design*, may also simplify your problems—or help to avoid costly and unnecessary motions. It's worth a try; next time you plan a spring, let us help, too!

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SMALL STAMPINGS • WIRE FORMS • HAIRSPRINGS • COLD ROLLED SPRING STEEL

WALLACE BARNES COMPANY
BRISTOL, CONN.

DIVISION OF THE ASSOCIATED SPRING CORP.

AND IN CANADA, THE WALLACE BARNES CO., LTD., HAMILTON, ONTARIO

This photograph shows an Oilgear variable displacement motor driving the rolls which pull continuous ribbons of steel from unwinder reels on the floor below into the annealing furnaces at the right.

The Oilgear Fluid Power "generator" or pump (at the left) furnishes fluid power to the Oilgear motor in photo No. 1, and to the second Oilgear constant displacement motor shown here. *This* Oilgear motor powers the rolls which pull the steel ribbons from the annealing furnaces, through plating tanks and a drying tower; it also powers the rewind reels shown at the right.

Pulling endless thin ribbons of steel through several hundred feet of equipment can become a headache . . . if the ribbon tension varies, or if one drive unit gets out of step.

Yet, handling such steel ribbons—for making steel strapping, barrel hoops, etc.—is a major part of the business of the Acme Steel Co. of Chicago and Riverdale, Illinois.

Twelve years ago, to learn how best to keep out of trouble, how best to keep production running smoothly, Acme installed two drives on identical equipment. One was an all-electric drive. The other an Oilgear Fluid Power Drive.

Mr. S. Rasul, Chief Engineer of the Riverdale Works, Acme Steel Company, writes as follows: "For over ten years Oilgear 20 and 35 H.P. drives have been operating our Steel Unit-Load processing Equipment 24 hours per day, six and seven days per week with negligible maintenance. Each drive is started and stopped frequently. Quick, cushioned hydro-dynamic braking eliminates wasteful over-run. Simple remote push-button controls at several stations provide quick synchronous starting and stopping of complete drives. For our work they have proved very satisfactory. Oilgear drives are also applied to coil winders and oscillating machines and are being used on new additional equipment now under construction."

All these advantages are gained simply, without special engineering provisions, by means of versatile, flexible Oilgear Fluid Power which probably can solve a majority of your drive problems too. Why don't you investigate Oilgear, foremost in fluid power? THE OILGEAR COMPANY, 1305 W. Bruce St., Milwaukee 4, Wisconsin.

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . . with or without preset time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed of a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full preset automatic control, elimination of problems of shock, vibration, etc.?

You Need Oilgear!

Oilgear Fluid Power

NOT A CRYSTAL BALL

OF THE FUTURE

but CHROME and STAINLESS

STEEL precision balls by the millions

for your 1947 production schedules.

For prompt delivery, tele-

phone, telegraph or write, giving

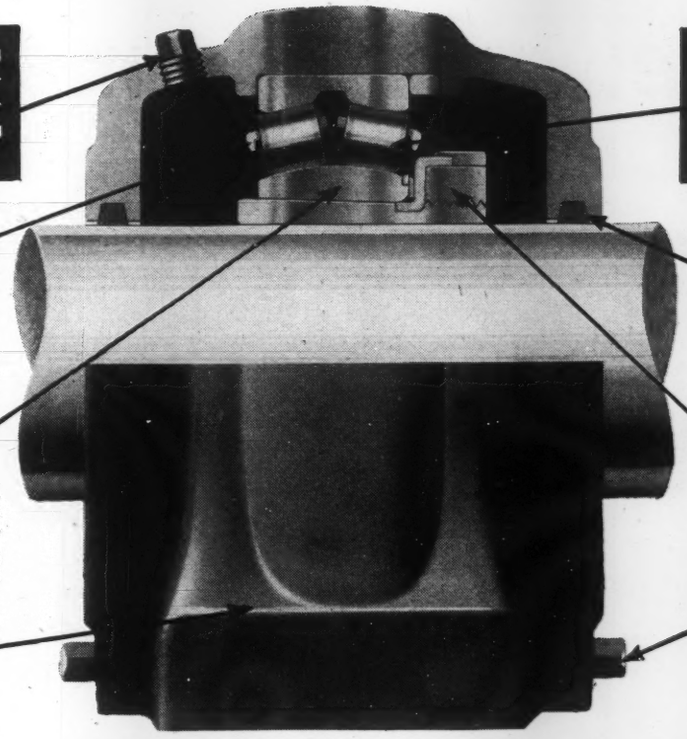
sizes required and end use.

UNIVERSAL BALL CO.

(A MODERN PRECISION BALL PLANT)

WILLOW GROVE MONTGOMERY COUNTY **PENNA.**

TELEPHONE: WILLOW GROVE 1200



Offers flexibility for using different methods of lubrication, such as grease, constant oil level or circulating oil system.

Heavy series precision-built double row self-aligning roller bearings.

Adapter type provides tapered sleeve to support inner race on shaft, giving secure mounting on commercial cold finished shafting. On precision turned or ground shafting the inner ring is press fitted directly on shaft for greatest accuracy of operation.

True flat surface gives solid bearing area for nut pressure.

Bearings can be either fixed or floated axially. "C" spacers may be removed or inserted to provide type required.

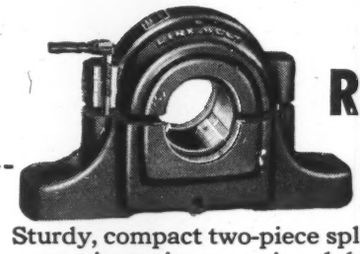
Felt seals for grease lubrication. "Spiro-Seals" for oil or grease lubrication.

Lock nut clamps assembly securely to shaft and is prevented from loosening by serrated lock washer.

Housings drilled and tapped for drain plugs on both sides for added convenience in draining oil or flushing solution.

"Service-Satisfaction" Features

OF LINK-BELT SELF-ALIGNING ROLLER BEARING PILLOW BLOCKS

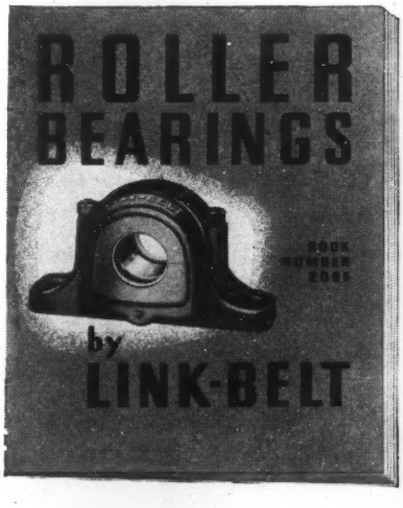


Sturdy, compact two-piece split housing provides convenience in mounting, lubrication and disassembly. Dowel holes in cap provided with standard screw thread for inserting a standard screw to raise cap off base without damage to finished surfaces. Base casting spotted for drilling for dowel pins to locate unit on supports. Slotted holes for foundation bolts.

Link-Belt Roller Bearings are all pointed to the one objective: the assurance of "service satisfaction" to the user. Here we point out certain features which are making major contributions to that objective. Link-Belt bearings can be furnished in pillow blocks, cartridge, flanged, take-up, hanger and duplex units, or without mountings for machine applications, etc.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, New York 7, Atlanta, Dallas 1, Houston 2, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities. 10,545



ROLLER BEARING BOOK No. 2095

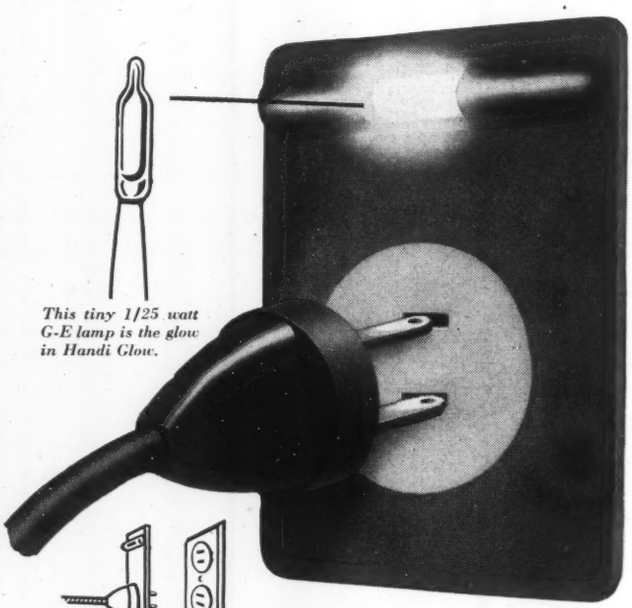
containing engineering data, capacities and dimensions will be gladly sent upon request.

LINK-BELT BALL AND ROLLER BEARINGS

Good news for bad memories

WHAT housewife hasn't put a strain on her husband's good nature by occasionally forgetting to turn off electrical appliances? Industrial Devices, Inc., Edgewater, N. J., has an answer to that universal problem. It's Handi Glow — a simple pilot light attachment that jogs the memory with a visual reminder that the appliance is "on." Fits any standard 2-prong plug. Transfers easily from one plug to another. Also can be used as a voltage test light.

Like many other successful wiring devices, the Handi Glow is equipped with a G-E Neon Glow Lamp— "*the glow that lets you know.*"



This tiny 1/25 watt G-E lamp is the glow in Handi Glow.

How Handi Glow plugs in.

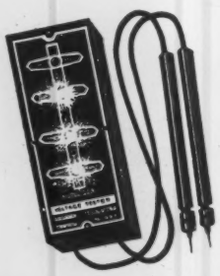
...and it's profit news to you!

TYPICAL WIRING DEVICES USING G-E GLOW LAMPS

SAFETY PILOT PLUG *combining nite-lite, 2-way plug and electric cord cap.*

LIGHTED SWITCH PLATE *ends fumbling. Light stays on when room is dark.*

MIDGET PILOT LIGHT *for permanent attachment to instrument panels and electrical apparatus.*



CIRCUIT TESTER *uses G-E Glow Lamps to give quick visual indication.*

THESE few wiring devices merely hint at the hundreds of ways G-E Glow Lamps are used to add sales appeal to appliances, instruments and electrical equipment of many kinds. The following G-E Glow Lamp advantages may suggest a valuable profit opportunity for you, too:

1. Distinctive orange-red glow—high visibility.
2. Dependable long life—in some types up to 25,000 hours.
3. Low current consumption—as little as 1/25 watt.
4. Low brightness, low heat.
5. High resistance to shock and vibration.
6. Can be installed in small space.
7. Variety of sizes and wattages.
8. Operate directly from regular 105-125 and 210-230 volt circuits, AC or DC.

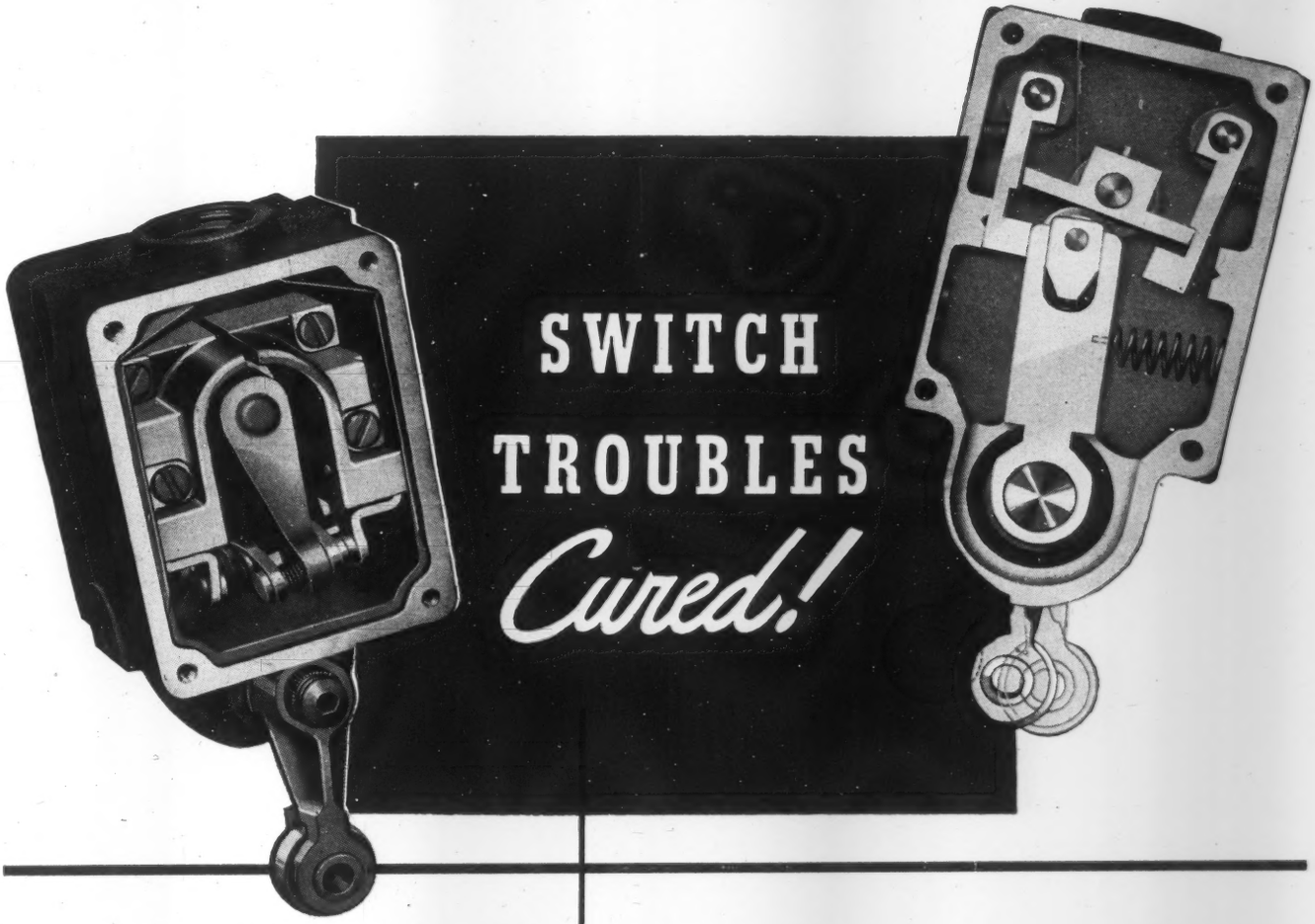
REMEMBER—***Every electrical device should have a live circuit indicator. G-E Glow Lamps are ideal for this purpose.***

SEND FOR free bulletin containing full information on G-E Neon Glow Lamps and their application to your product.

G-E LAMPS

GENERAL ELECTRIC

Nela Specialty Div. Lamp Dept., 1 Newark St., Hoboken, N. J.



SWITCH TROUBLES *Cured!*

HERE ARE SOME OF THE USUAL CAUSES OF LIMIT SWITCH FAILURE	HERE ARE SNAP-LOCK'S PROVED REMEDIES
Arcing	Large area wiping contacts. Snap make and break.
Worn or pitted contacts	Pure silver contacts.
Uncertain position	Positive locking in either on or off position. Cannot stop on dead center.
Insulation failure	Electric mechanism in own separate, heavily insulated compartment.
Mechanical wear	Hardened steel moving parts—forged operating lever.
Ordinary commercial-grade switches often show signs of breakdown after 500,000 cycles of operation or less.	On actual fatigue test, Snap-Lock unchanged after 16,000,000 cycles. Bulletin EM-42 gives details.

The NATIONAL ACME CO.

170 EAST 131st STREET • CLEVELAND 8, OHIO

Acme-Gridley Bar and Chucking Automatics: 1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

ELECTROL'S

NEW DOUBLE ACTION

INDUSTRIAL HYDRAULIC HAND PUMP

This low-cost, efficient, rugged and simplified unit—*designed specifically for industrial use*—is backed by years of experience in the production of precision hand pumps for Navy combat aircraft. It has large capacity and few moving parts. Requires practically no maintenance. Double action assures speedy operation with minimum effort.

Specifications

Weight 8 lbs • Bore 1¼" • Stroke 1¼" • Volume 1.5 cu. in. per cycle • Pressure range 0 to 1,500 PSI • Handle load at 500 PSI, 17 lbs • at 1,000 PSI, 35 lbs • at 1,500 PSI, 52 lbs • Housing 7-3/16" X 3" X 2½" • Foot-mounting type with 4 holes for ¼" bolts • Suction and pressure ports ⅜" NPT—both on same face • Piston rod chromium plated • Piston rod bearing made of bronze • 22" metal handle operates through a maximum arc of 60 degrees.

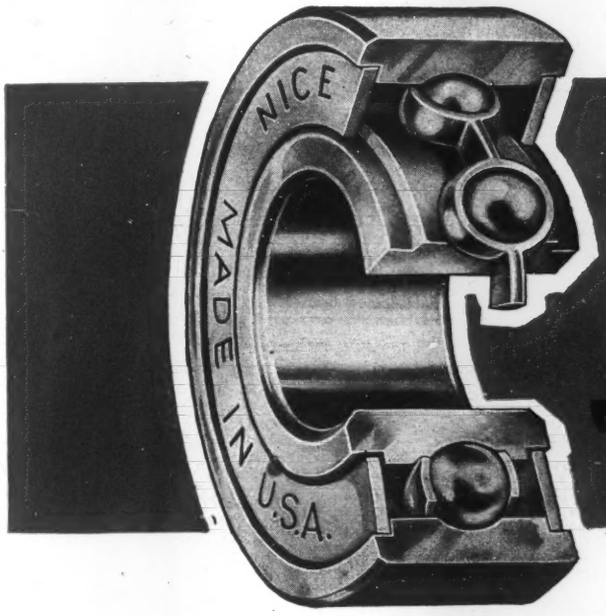
For further information, write today!

ELECTROL INCORPORATED

FOR BETTER HYDRAULIC DEVICES

KINGSTON, NEW YORK

CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES • CHECK VALVES • RELIEF VALVES • HAND PUMPS • POWERPAKS LANDING GEAR OLEOS • SOLENOID VALVES ON-OFF VALVES • SERVO CYLINDERS TRANSFER VALVES • CUT-OUT VALVES SPEED CONTROL VALVES



NICE INTRODUCES "SERIES 3000"

Now Available for Prompt Delivery. A New INCH SIZE Line of Low Cost Unground Radial Bearings with Solid Inner and Outer Rings and Ball Retainer.

3000 SERIES DIMENSIONS AND LIST PRICES

BEARING NUMBER			BORE	OUTSIDE DIAMETER		WIDTH	CORNER RADIUS	BALL DIAM.	LIST PRICE	CODE WORD		
NO SHIELDS	SINGLE SHIELD	DOUBLE SHIELD	INCHES +.005 −.000	INCHES	TOLERANCE +.0000 TO MINUS	INCHES +.005 —.005	INCHES	INCHES		NO SHIELDS	SINGLE SHIELD	DOUBLE SHIELD
3001NS	3001SS	3001DS	3-16	11-16	−.0005	1-4	.015	1-8	.45	JENBE	JIBBE	JODBE
3002NS	3002SS	3002DS	1-4	11-16	−.0005	1-4	.015	1-8	.45	JENAB	JIBAB	JODAB
3005NS	3005SS	3005DS	5-16	29-32	−.0005	5-16	.015	1-8	.45	JENCH	JIBCH	JODCH
3006NS	3006SS	3006DS	3-8	29-32	−.0005	5-16	.015	1-8	.45	JENFO	JIBFO	JODFO
3007NS	3007SS	3007DS	7-16	29-32	−.0005	5-16	.015	1-8	.50	JENGU	JIBGU	JODGU
3014NS	3014SS	3014DS	3-8	1 1-8	−.0005	3-8	.025	3-16	.50	JENDJ	JIBDJ	JODDJ
3015NS	3015SS	3015DS	7-16	1 1-8	−.0005	3-8	.025	3-16	.50	JENEN	JIBEN	JODEN
3016NS	3016SS	3016DS	1-2	1 1-8	−.0005	3-8	.025	3-16	.50	JENHA	JIBHA	JODHA
3020NS	3020SS	3020DS	7-16	1 3-8	−.0005	7-16	.025	7-32	.55	JENIC	JIBIC	JODIC
3021NS	3021SS	3021DS	1-2	1 3-8	−.0005	7-16	.025	7-32	.55	JENLD	JIBLD	JODLD
3022NS	3022SS	3022DS	9-16	1 3-8	−.0005	7-16	.025	7-32	.55	JENJF	JIBJF	JODJF
3023NS	3023SS	3023DS	5-8	1 3-8	−.0005	7-16	.025	7-32	.55	JENNK	JIBNK	JODNK
3033NS	3033SS	3033DS	5-8	1 3-4	−.0005	1-2	.025	1-4	.75	JENPS	JIBPS	JODPS
3034NS	3034SS	3034DS	11-16	1 3-4	−.0005	1-2	.025	1-4	.75	JENRZ	JIBRZ	JODRZ
3035NS	3035SS	3035DS	3-4	1 3-4	−.0005	1-2	.025	1-4	.75	JENSV	JIBSV	JODSV
3038NS	3038SS	3038DS	3-4	2	−.0006	9-16	.035	1-4	.90	JENTW	JIBTW	JODTW
3039NS	3039SS	3039DS	13-16	2	−.0006	9-16	.035	1-4	.90	JENUM	JIBUM	JODUM
3040NS	3040SS	3040DS	7-8	2	−.0006	9-16	.035	1-4	.90	JENVT	JIBVT	JODVT
3041NS	3041SS	3041DS	1	2	−.0006	9-16	.035	1-4	.90	JENWG	JIBWG	JODWG

Outside diameter has ground finish to indicated tolerances.

Corner Radius indicates maximum fillet radius in housing or on shaft which bearing radius will clear.

The above list prices apply to 3000 DS, SS and NS types for quantities up to 99 pieces. See discounts on page 6, Catalog No. 125 or 125A. Write for special net prices on larger quantities.

NICE

NICE BALL BEARING COMPANY

NICETOWN · PHILADELPHIA · PENNSYLVANIA

Washing-Machine Makers "Wring Out" *More* Production Savings- Dealers Ring Up *More* Sales

***...when costs toboggan and style steps up via* AMERICAN PHILLIPS SCREWS**

HERE'S THE PRODUCTION "WHY": Super speed on the line—from *automatic*, straight, "non-stop" driving! American Phillips Screws spare work and worker—make power driving really pitch for you in speedier handling . . . in savings on screws (fingers can't fumble, heads can't burr) . . . in scratchless, matchless safety for work surfaces. Many manufacturers making appliances, autos, or what-not, get a bonus in total time-savings up to 50%!

HERE'S THE PROMOTION "WHY": Customers like the streamlined look that this *modern* fastening furnishes. American Phillips Screws go with everything your product embodies that says *high style* and *long service.* Write American today for fastening facts that can cut *your* costs.

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

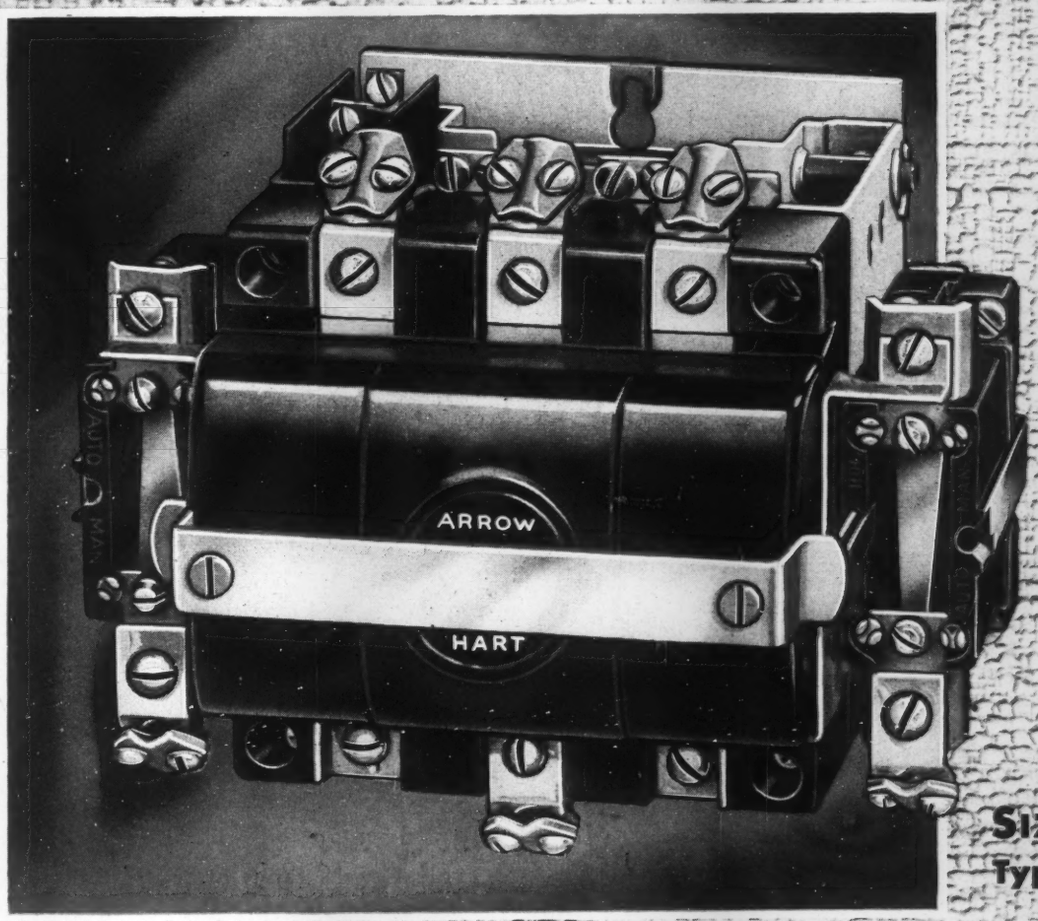
Chicago 11: 589 E. Illinois Street *Detroit 2:* 502 Stephenson Building

AMERICAN PHILLIPS *Screws*

ALL TYPES

ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

NEW MAGNETIC STARTER



SIZE 2; Type RA

NEW-PRINCIPLE BALANCED MECHANISM provides full use of magnet power without lifting extra weight. Requires but 8.5 Watts closed, 75 Watts inrush. The straight-line horizontal action brings equal contact pressure to each pole. Efficient, durable to a new degree, — permitting a compact design about *half the size* of the conventional Starter for motors up to 25 H. P. . . Write for illustrated 4-page folder describing *all* new features.

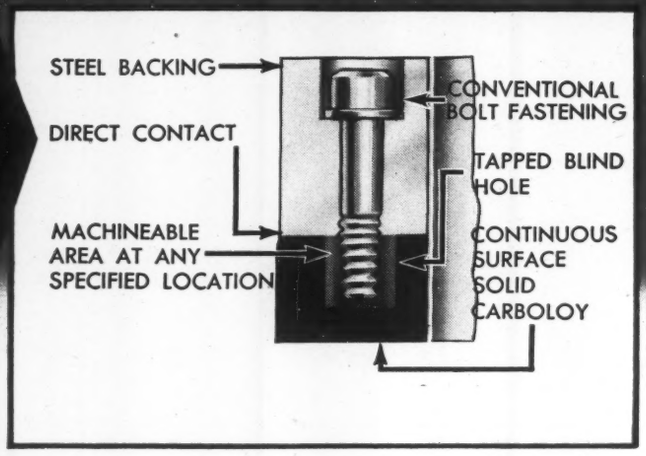
ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U. S. A.

NOW! ATTACH CARBOLOY*

WHEREVER YOU NEED IT

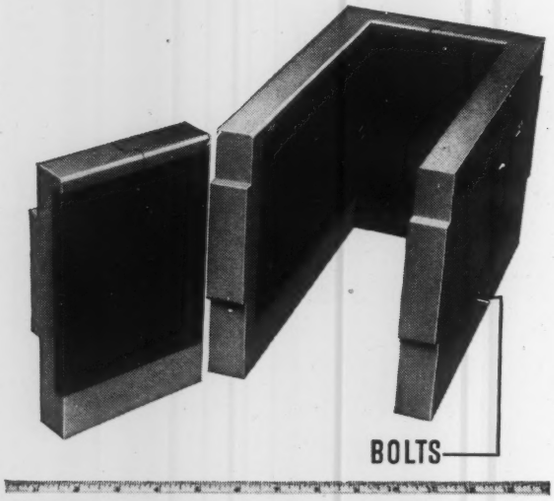
WITH BOLTS!



New Mounting Method Provides Uninterrupted Carboloy Surfaces by Bolting to Tapped Blind-Holes

New—exclusive . . . this Carboloy-developed mounting-method tremendously widens cemented carbide's range of usefulness!

Carboloy Cemented Carbide sections are supplied to your specifications, already equipped with machineable inserts which may be drilled and tapped for bolting into place. Very large sections of carbide can now be easily mounted where needed. By blind-tapping, "through holes" are eliminated, giving continuous uninterrupted surfaces. Direct contact of carbide with back-up metal increases impact resistance. Users can specify desired locations of attachment points, and drill and tap inserts in their own shop.



TYPICAL WEAR APPLICATION shown here illustrates how the new method makes possible attaching large sections of wear-resistant Carboloy without use of "through-holes" thereby obtaining a continuous uninterrupted surface. Carboloy section shown here measures 6⅜" x 9½.

Typical of the range of applications are: Wear parts on fixtures, machine ways, guides, work rests and shoes, compound, progressive and segmented dies, crank guides, cam liners, punches, wear plates, and many others. For further details, write: Carboloy Company, Inc., 11113 E. 8 Mile Ave., Detroit 32, Michigan.

CARBOLOY CO. INC.

11113 E. Eight Mile Ave., Detroit 32, Mich.

CARBOLOY (TRADEMARK) CEMENTED CARBIDE HARD METAL

STAINLESS STEEL

Women Like it

They like its lasting luster and the ease with which it can be kept clean. You'll like stainless steel, too, for it will give your products strength and toughness, as well as eye appeal. And remember stainless steel is available in as many as 8 different permanently lustrous finishes—ranging all the way from dull satin to mirror-bright. If you're interested in how others are using this versatile metal in the design of their products, write to Department B-5 for our monthly publication ELECTROMET REVIEW.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

PRODUCERS OF ALLOYS THAT MAKE STEEL STAINLESS

Beautiful Enduring Strong Tough

Designers' choice of Piping Equipment . . . in brass, iron, and steel

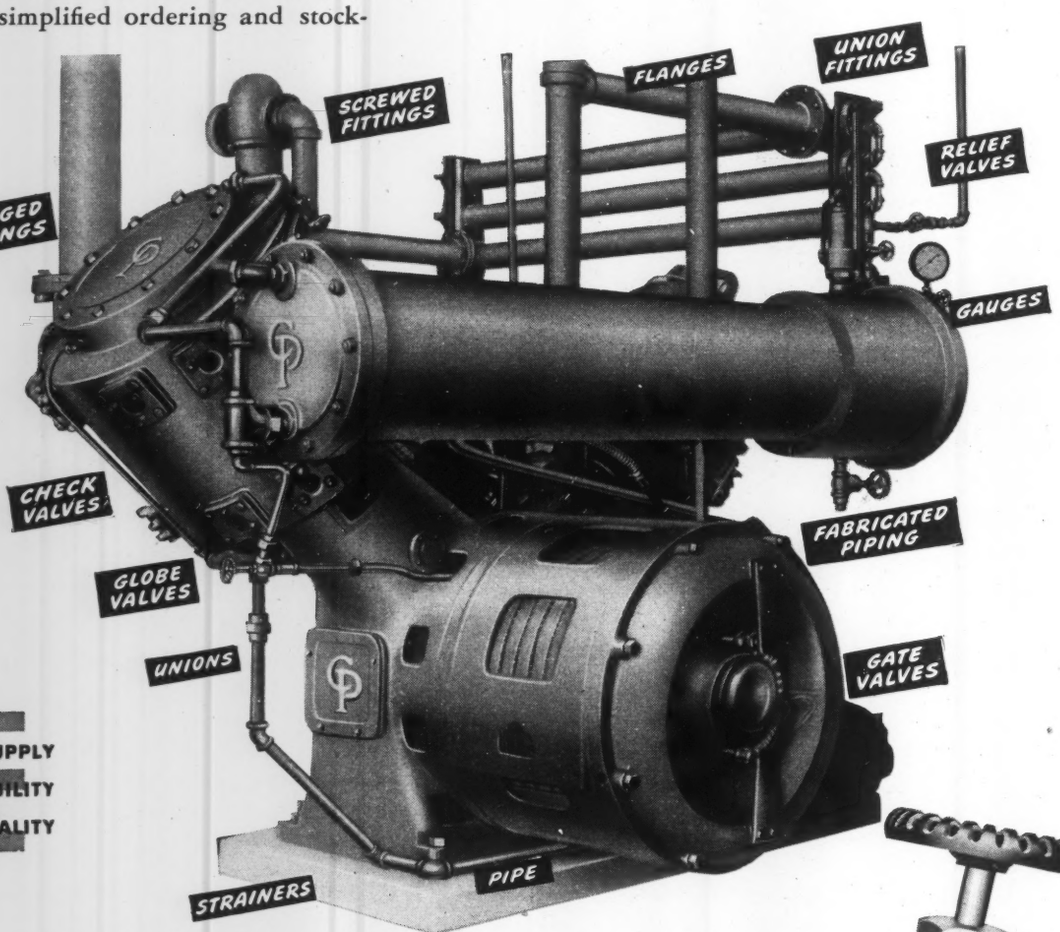
You may be specifying equipment for an air compressor . . . or for a chemical processing unit. In either case, as for every design, piping selection is no problem when you work with Crane.

Reach for the Crane Catalog always, for the choice you want of valves, fittings, pipe, accessories, and fabricated piping . . . in every type and size . . . in materials for every application. It's the line you can standardize on, and be right every time.

Equipping with Crane means time saved in specifying. It means simplified ordering and stocking of parts. Because Crane supplies everything, single responsibility for piping materials results in smoother assembly operations; better control of factory schedules.

To machinery buyers, Crane equipment signifies added value. They know the extra dependability of Crane piping materials, and their easy availability when replacements become necessary.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Model Y-CM Two-stage, Double Acting Compressor by Chicago Pneumatic Tool Company.

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

(Right) *GOOD CHOICE FOR AIR SERVICE*—Crane No. 7 Brass Globe and Angle Valves with renewable composition disc. Special long-wearing Cranite disc insures tight seating under severe usage. Finest materials and design throughout. Specify No. 7's for air pressures up to 300 lb.; Steam rating, 150 lb. Also supplied for other services with proper composition disc. See your Crane Catalog, page 30.

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

Truly Intimate Contact through

Helicoidal Surfaces

...Design Solution to Heavy-Load Clutches

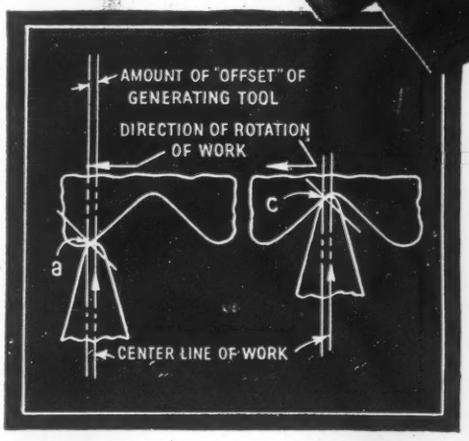
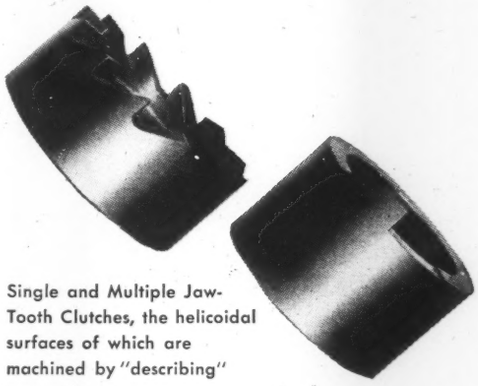


Diagram illustrating the method employed in cutting face gear-type clutches by the "describing" generating method.

More satisfactory, longer service are advantages that accrue from face-gear type clutches with Helicoidal Contacting Surfaces, which can be generated to precision tolerances on the Gear Shaper. Intimate surface contact is thus accomplished between engaging teeth... heavy loads are carried on a full surface rather than a "line".

This and many other interesting design applications of the generated precision contours possible with Gear Shaper machining are illustrated in our booklet "The Art of Generating with a Reciprocating Tool". The Fellows Gear Shaper Company, Head Office and Export Dept., Springfield, Vermont; Branch Offices: 616 Fisher Bldg., Detroit 2... or 640 West Town Office Bldg., Chicago 12.

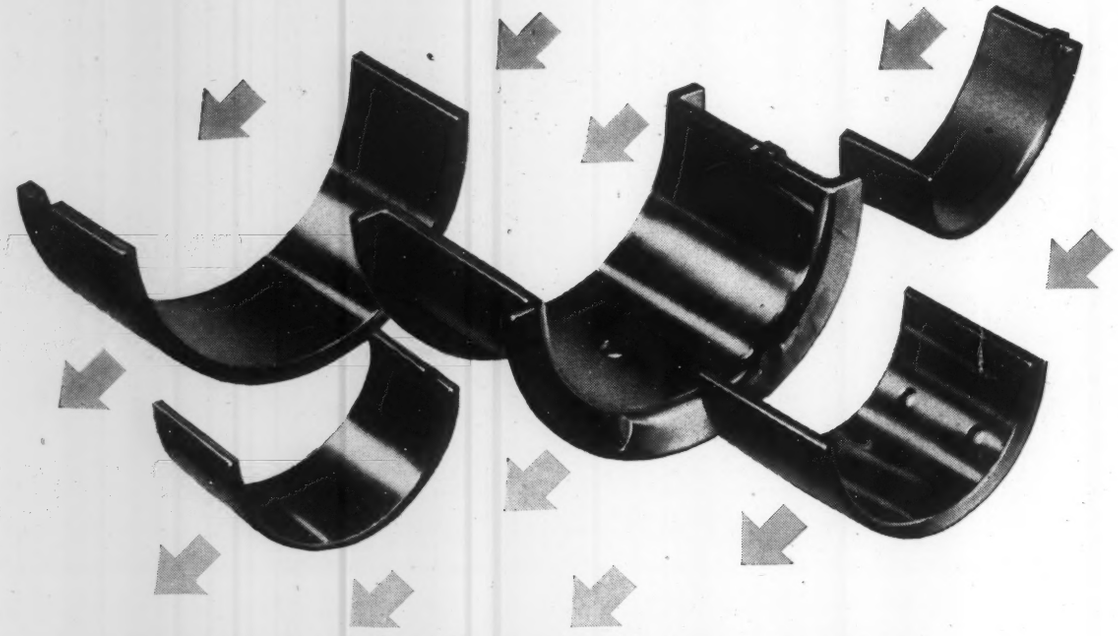


Single and Multiple Jaw-Tooth Clutches, the helicoidal surfaces of which are machined by "describing" generating.

★ HAVE YOU SEEN the latest in gear science... the Fellows sound motion picture in natural color... "The Art of Generating" and "Gear Manufacturing Equipment." Contact Springfield, Vermont, or our local offices for booking appointments.

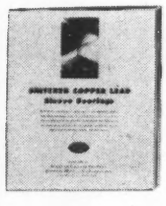
Fellows

THE FELLOWS METHOD...MACHINES AND TOOLS FOR ALL OPERATIONS FROM BLANK TO FINISHED GEAR



LONGER BEARING LIFE . . .
HIGHER PERFORMANCE STANDARDS
by the use of Improved
Powdered Metal SINTERED Copper Lead Alloys

- ★ exceptional purity
- ★ known and controllable grain structure
- ★ ductility and strength superior to cast materials
- ★ excellent lead distribution
- ★ no segregation of lead
- ★ up to 45% lead content
- ★ no overplating required with higher lead content
- ★ overplating recommended with lower lead content
- ★ hard crankshafts not necessary



FREE BULLETIN. A new technical bulletin has been published describing the development of this improved alloy. A copy will be sent free on request.

FEDERAL-MOGUL CORPORATION, 11045 Shoemaker, Detroit 13, Michigan

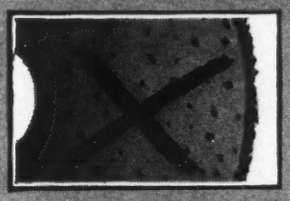
Power goes to work smoothly through

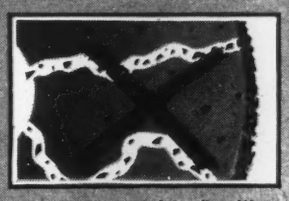
FEDERAL-MOGUL

Silent FEDERAL Mogul **SLEEVE BEARINGS**

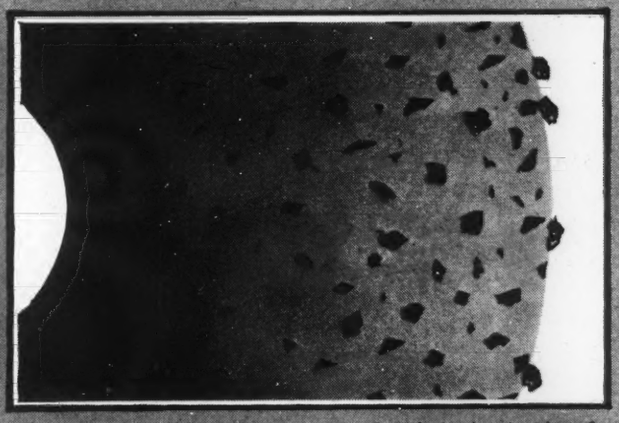
Before You Build In a Micronic Filter Make Sure You Understand This REVOLUTIONARY PRINCIPLE . . . It Means a

50% SAVING in cartridge replacement costs





Other depth-type filters are susceptible to surface loading and channeling. Minimum openings on pressure side cause dirt accumulation on surface — element clogs before filling. Uncontrolled distribution of filter media in element permits fluid to find channels, passing solids larger than specified.



Cross-section of MICRO-KLEAN filter cartridge. A newly-developed method of "felting" and impregnating micronic fibres creates a fibre distribution which increases in density in direction of flow. Spaces between fibres become progressively smaller and more numerous approaching discharge surface. Graded Density in Depth eliminates surface-loading, permits more solids of all sizes to be collected within the element. Resinous impregnation bonds each fibre in position, preserving original fibre distribution, giving absolute protection against channeling, rupturing, shrinking, distortion.

This Filter answers your need for protecting against micronic particles *at low cost for cartridge replacement*.

Two exclusive construction features (see above) allow the Cuno MICRO-KLEAN to collect more solids before clogging — *doubling* the usual effective life.

Cuno Micro-Klean Filters Are Ideal for Built-In Installations

If you now use replaceable cartridge type filters, a trial installation of Micro-Klean filters will prove their double efficiency. Standard cartridges now available are furnished in a wide range of housing designs. Special lengths can be supplied. Write for sample cartridges for test installation.

CUNO

Fluid Conditioning

REMOVES MORE SIZES OF SOLIDS FROM MORE TYPES OF FLUIDS

AUTO-KLEAN General service down to .0035." Disc-type. Continuously cleanable.

FLO-KLEAN For highly abrasive solids down to .0025." Wire-Wound. Continuously cleanable.

MICRO-KLEAN Micronic-type. Molded Fibre. "Graded Density in Depth" cuts replacement cost.

COOLANT-KLEAN Low-cost unit filtration of grinder coolant. Fabric-type element.

SEND COUPON FOR FREE FACTS TO FIT YOUR INSTALLATION

CUNO ENGINEERING CORPORATION
201 South Vine Street, Meriden, Conn.

Please have nearest Cuno representative provide information relative to services checked:

☐ Lubricating Oil ☐ Water and Water Solutions ☐ Hydraulic Oil ☐ Compressed Air ☐ Fuel Oil ☐ Acids

Write any other fluid-cleaning problems here.....

.....

Send free sample cartridges for: (state use).....

.....

Name.....*Title*.....

Company.....

Address.....

SILVER SOLDERS

for

SPEED • ECONOMY • DURABILITY

WIRE OR ROD

SOLDER STRIP

POWDERED SOLDER

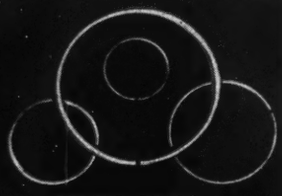
BURRED SOLDER

The D. E. Makepeace Company has long pioneered in the development of silver solders. With more than a half century of accumulated experience behind us, we have, today, developed a variety of silver-brazing alloys to meet practically every industrial requirement.

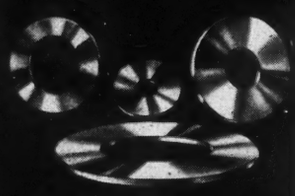
These solders flow easily, penetrate deeply and diffuse evenly. The joints so affected are stronger, in most instances, than the parts joined and the junction is durable, ductile, leakproof, corrosion resistant, and high in electrical and thermal conductivity.

Today, preplaced solder rings or solder washers and induction heating are revolutionizing former soldering methods. Likewise, modern alloys and light gauge metals, likely to be damaged by high temperature brazing or welding, have been particularly aided by the use of our low temperature, fast spreading silver solders.

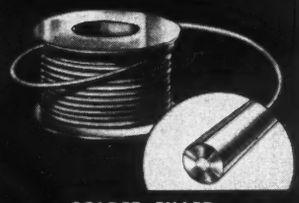
Should you have a special soldering or brazing ploblem, our fully equipped research and testing laboratory is at your service. Our informative folder listing precious metal solders, with helpful melting and flow-point tables, will be sent you upon request.



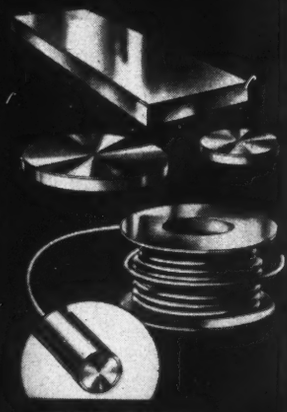
SOLDER RINGS



SOLDER WASHERS



SOLDER FILLED WIRE



SOLDER FLUSHED SHEET • DISCS • WIRE

START RIGHT with **Makepeace** PRODUCTS

SHEETS • WIRE • TUBING • SOLDERS • FABRICATED PARTS AND ASSEMBLIES

D. E. MAKEPEACE COMPANY

Main Office and Plant, Attleboro, Massachusetts

NEW YORK OFFICE, 30 CHURCH ST. CHICAGO OFFICE, 55 EAST WASHINGTON ST.

Open the way toward getting UNIFORMITY in the Small Gears you buy! G.S. precision methods and machinery offer you the key to all that is newest and best in Fractional Horsepower Gear manufacture. Here, you'll get the friendly cooperation of *experts* . . men who have devoted a lifetime to the design and quantity production of *Small Gears exclusively.* Here, too, is every device known to modern science for producing gear after gear . . whether it's one hundred or one hundred THOUSAND . . to a degree of uniform accuracy heretofore considered impossible! If a Fractional Horsepower Gear is involved, by all means discuss its design and its function with a G.S. engineer. Get valuable information and cost estimates without cost or obligation. Discover for yourself why "G.S." has become the "WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS"!

SEND FOR . .

the G.S. 4-page Bulletin which illustrates and describes many different types and applications of G.S. Small Gears. Will you ask for a copy on company stationery, please?

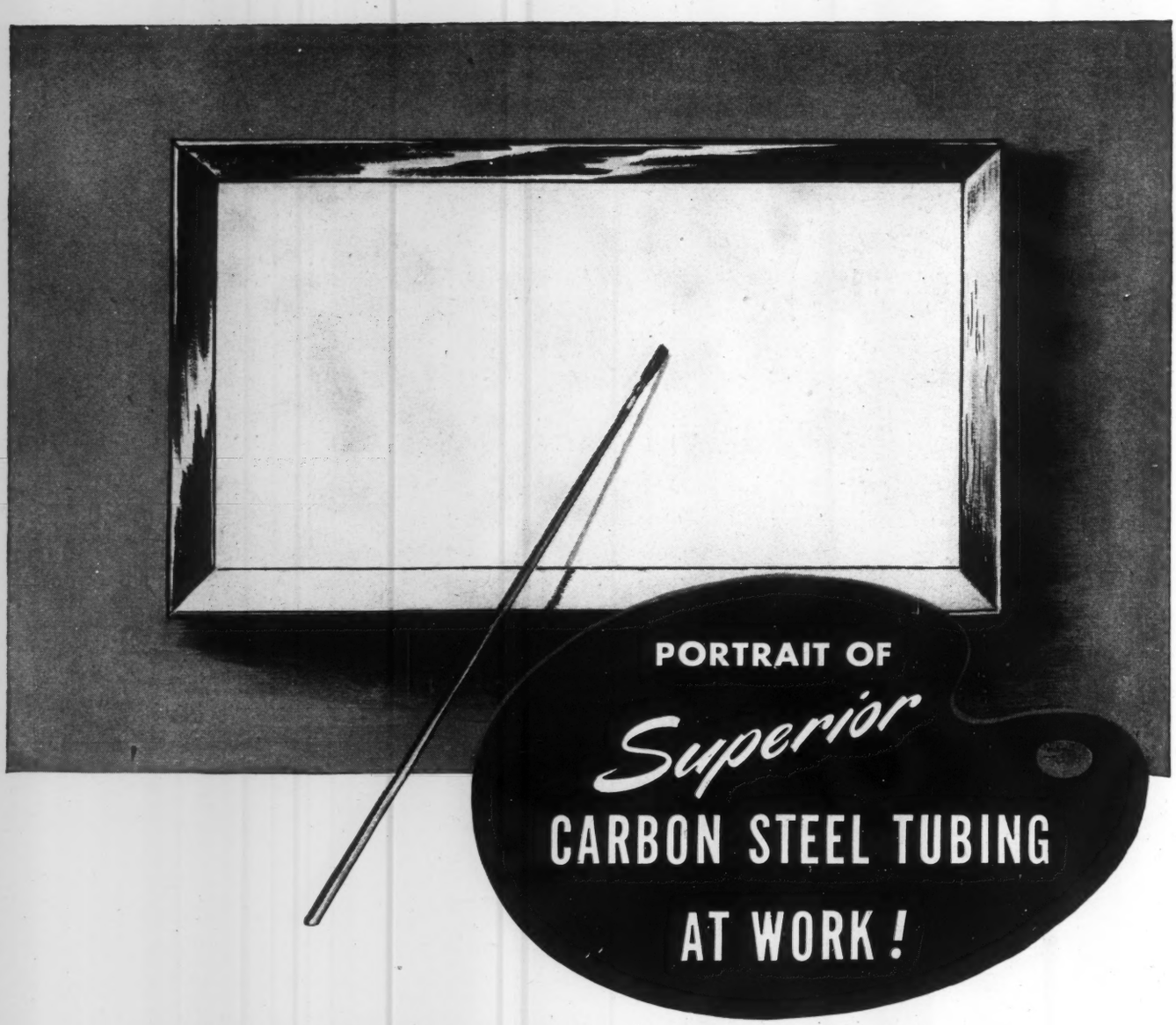
GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE • CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS



No, our advertising department didn't forget to put a picture in the frame—actually we are illustrating a point that is important to users of small carbon steel tubing.

IN MANY CASES SUPERIOR TUBING LOSES ITS IDENTITY—because it becomes machine parts, pressure lines, electrical connectors, bushings, spacers, valve parts, aircraft structural members, even parts of toys—few of which are recognizable as tubing as we produce it.

And on This Fact Hangs Superior's Place in Your Picture

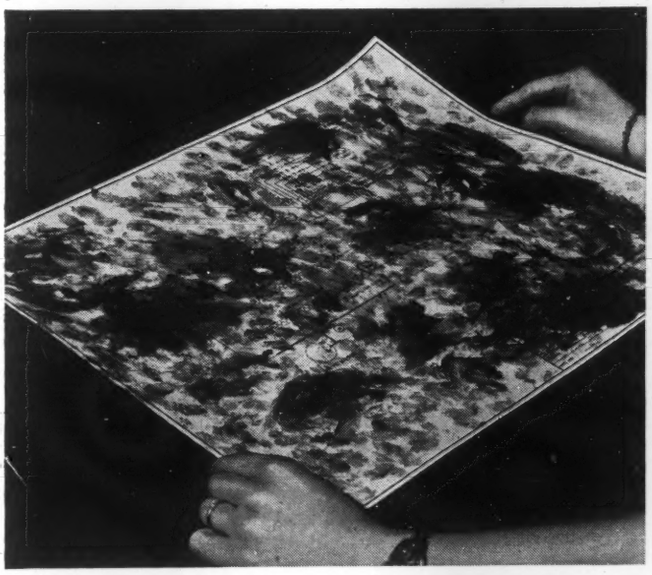
It takes "Superior grade" carbon steel tubing to meet your requirements for forming, bending, machining, threading, flaring, tapering, and slitting. What you can do in your fabricating is a direct function of the operations at our mill.

Superior fine small carbon steel tubing is available in many sizes from warehouse stock of selected Steel Distributors all over the Country—or is produced to your specifications by Superior and sold through these distributors. If you don't know whom to contact in your locality, write us direct.

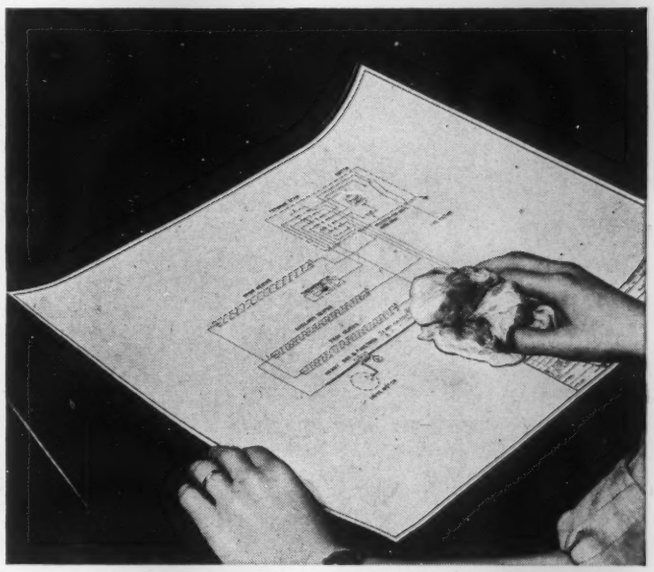
THE BIGGER NAME IN SMALL TUBING Superior

SUPERIOR TUBE COMPANY
2010 Germantown Ave.
Norristown, Pennsylvania

The worst "beating" any print ever took!



Immersed in water for 72 hours! Then oil was poured over it... and, just before this picture was taken, it was smeared with heavy grease!



Here is the same Ozaplastic print seconds later! ... As good as ever, simply cleaned with a damp cloth!

OZAPLASTIC eliminates 95% of your print replacement costs . . . is recommended whenever the going is tough ...where standard paper or cloth prints "fold up" after a short period of service.

You'll want to use Ozaplastic in the shop and field ... around operations where grease, grime, or water abound ... where precision is of the utmost importance ... where annoyances—such as having to wait for a new print—put a hitch in production.

When soiled, you need only rub a damp cloth over Ozaplastic and it's like new—all details sharp and clear, *jet black* on a glossy white background.

For this reason, OZAPLASTIC is also used in sales catalogs and presentation booklets—even laminated on machines, etc., when "on-the-spot" instructions or wiring diagrams are required.

Now . . . Make 16 Types of Ozalid Prints!

OZAPLASTIC is only one of the 16 different types of prints you can produce in an Ozalid machine.

For example, you can reproduce the lines and images of any translucent original in black, blue, red, sepia, or yellow colors. And make prints on white or tinted paper, cloth, foil, film, or plastic.

Thus, you can "color code" prints of different operations . . . and always match the print to the job at hand.

Furthermore, all of these Ozalid prints are made in exactly the same manner—without interruption—in 30 seconds or less.

See the 16 different types of Ozalid prints. Learn how economical it is to make them in the new OZALID STREAMLINER.

Write today for free booklet No. 269.

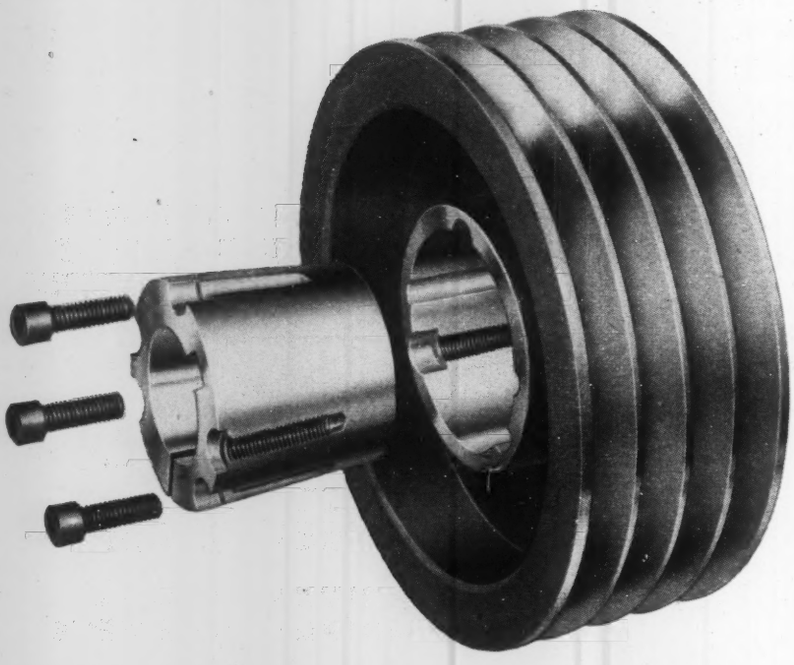
OZALID

DIVISION OF GENERAL ANILINE AND FILM CORPORATION

JOHNSON CITY, NEW YORK

Ozalid in Canada—Hughes Owens Co., Ltd., Montreal

TAPER-LOCK BRAND



THE NEW TIME-SAVING TAPER BORE SHEAVE

TAPER-LOCK has the simplest, surest mechanism ever devised for holding wheels to shafts...TAPER-LOCK saves time. You slip it on the shaft, line it up and tighten while sighting...TAPER-LOCK runs true. It holds with a firmness equivalent to a shrunk-on fit, yet it disengages with less effort than any other sheave.

TAPER-LOCK sheaves are available in all the most wanted sizes. Thus Dodge has not only created a great new product in the power transmission field, but has made this product adaptable to needs throughout industry.

TAPER-LOCK is a striking example of the new Dodge products which help you put more power on the job — cut costs and increase production. The savings which Dodge equipment make possible will be important to you in the competitive days ahead. Get the full story — now.

DODGE MANUFACTURING CORPORATION
MISHAWAKA • INDIANA

IN ALL THESE STOCK SIZES:

CLASS SHEAVE	PITCH DIAMETER	NUMBER GROOVES	TOTAL SIZES
DUAL DUTY "A"	3.0 to 18.0	1 to 6	150
DUAL DUTY "B"	4.6 to 18.4	1 to 6	114
B	5.4 to 38.0 20.0 to 38.0	7 to 10 2 to 10	76 36
C	9.0 to 44.0	3 to 10	128
D	13.0 to 33.0	4 to 10	77

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER

He's a factory-trained specialist qualified to analyze your mechanical power transmission needs and recommend correct equipment. Consult him without obligation. Look for his name under "Power Transmission Equipment" in your classified telephone directory.

Copyright, 1947, Dodge Mfg. Corp.

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, ETCHING COMPANY OF AMERICA, 1520 MONTANA STREET, CHICAGO 14, ILLINOIS

Now! YOURS FOR BETTER PERFORMANCE!

Centrifugally Cast BUSHING STOCK By Shenango-Penn

ASK FOR FREE BULLETIN No. 145

It contains additional data, including complete list of stock sizes, diameters and weights of Shenango-Penn machined centrifugally cast tubular bars and chill-cast solid bars . . . all available for immediate shipment.

IF you use bushing stock, why not get, at prevailing prices, the best that money can buy?

The same centrifugal casting techniques that make Shenango-Penn a preferred source of supply for long-lived, made-to-order bearings, bushings, sleeves, liners, rolls, etc., are now offered in Shenango-Penn tubular bushing stock!

Thus you gain many advantages: finer, pressure-dense grain, an 8 to 20% increase in tensile, finely divided and uniform lead dispersion, superior wear resistance, as much as 30% greater elongation, and *positive* relief from sand inclusions or blow holes. Here's bushing stock that's ready now to give you a big extra margin of safety, service-life and over-all economy.

Send for free descriptive bulletin No. 145 and the address of the Shenango-Penn sales office nearest you.

SHENANGO-PENN

SHENANGO-PENN MOLD COMPANY

1268 West Third Street • Dover, Ohio

EXECUTIVE OFFICES • PITTSBURGH, PA.

ALL BRONZES • MONEL METAL • ALLOY IRONS

Two-Cylinder

THE NEW ONAN AIR-COOLED 10 H.P. 4-CYCLE "CK" ENGINE

Installation and operating problems facing manufacturers and designers of engine-driven equipment are solved by the many design features of the new Onan "CK" engine. It can improve present products and simplify development of new equipment. Applications are practically unlimited.

The "CK" has a wide power range. It can be operated at a wide angle from the vertical. It is light, compact, easily mounted, with easy-to-get-at controls.

The standard "CK" engine is "de luxe" equipped . . . no "extras" to buy. It has fuel pump, oil-bath air cleaner, built-in precision governor, downdraft concentric carburetor and oil pressure gauge.

Full capacity mass-production assures prompt delivery on early orders.

If you have a gasoline-engine power problem, write us.

5.5 HORSEPOWER SIZE AVAILABLE. The 5.5 h.p. "BH" is a smaller version of the "CK", with the same design and operating features. Weighs 75 pounds and fits into 14 x 16 x 17 inch space.

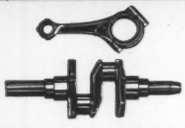
ONAN AIR-COOLED ENGINES—CK: 2-cylinder opposed, 10 h.p.; BH: 2-cylinder opposed, 5.5 h.p.; 1B: 1-cylinder, 2.5 h.p.

ONAN ELECTRIC PLANTS—A.C.: 350 to 35,000 watts in standard voltages and frequencies. D.C.: 600 to 10,000 watts, 115 and 230 volts. Battery chargers: 500 to 6,000 watts, 6, 12, 24, 32 and 115 volts.

WRITE FOR SPECIFICATIONS ▷

D. W. ONAN & SONS INC.
4336 ROYALSTON AVE.
MINNEAPOLIS 5, MINN.

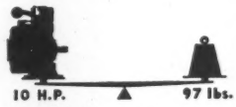
PLUS POINTS



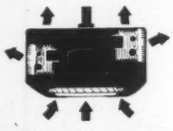
HEAVY DUTY CONSTRUCTION: Short, sturdy crankshaft. Extra-large bearings, 1⅝" diam. rod; 2" diam. main.

COMPACT, LIGHT WEIGHT: Fits into 15 x 19 x 18 inch space. Weighs only 97 pounds.

SMOOTH POWER: Opposed 2-cylinder, balanced design. Power impulses evenly spaced. Fully counterbalanced crankshaft.



ALUMINUM CONSTRUCTION: High-strength aluminum castings reduce weight. Give superior thermal conductivity.



SUPER COOLING: Axial-flow fan delivers 600 cu. ft. of cool air per minute. Larger fin area.

ELECTRIC STARTING AVAILABLE: Built-in electric push-button or automatic starting adds only 2⅞" to length.

ONAN 4-Cycle ENGINES

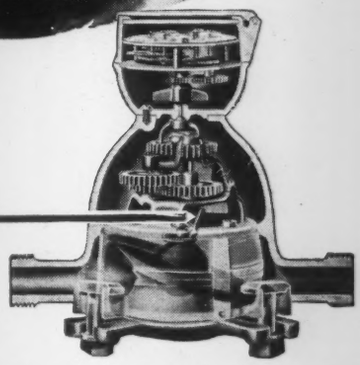
RIVERSIDE PHOSPHOR BRONZE HELPS KEEP THE RECORD STRAIGHT . . .

● Your Uncle Sam (We Americans) consume billions and billions of gallons of water every year. Water meters need herculean stamina to stay on the job 24 hours a day year after year accurately measuring all this water. Water has tremendous solvent powers (it even eats away hard rock), and it is a potent corrosive agent. Therefore component parts of a water meter must be made of the finest non-corroding materials obtainable.

Worthington-Gamon Meter Company, a cardinal producer of water meters (see above) use *Riverside Phosphor Bronze* for spindles and pinions, vital parts, which are subject to arduous punishment.

Riverside Phosphor Bronze has exceptionally high resistance to wear and to corrosion in dampness, fumes and salt and acid waters. It will not rust and it has a low coefficient of friction, presenting a good bearing surface.

Riverside Phosphor Bronze's advantages enable designers to plan better, more efficient products and effect many production economies. Investigate this remarkable alloy now and also get the story on *Riverside Nickel Silver* and *Beryllium Copper*. Write for catalogs.



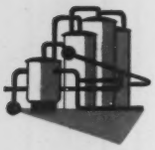
Sectional View of Worthington-Gamon Watch Dog Disc Water Meter. Spindles and pinions are made of *Riverside Phosphor Bronze*.

INSIDE RIVERSIDE

Antidote Department: It'll take more than an ice bag to cure lead time headaches in the metal industries but—keep your fingers crossed—there is hope. We're still not boasting about our own lead time, but if you need something special in our field, count us *in* before you count us out. We may be able to help you.

RIVERSIDE

THE
RIVERSIDE METAL COMPANY
NEW YORK CHICAGO RIVERSIDE • NEW JERSEY HARTFORD CLEVELAND



...high octane gasoline

...electric household appliances

partners in creating

● Creative men...engineers and engineering draftsmen...plan and build things to last. By the same token they look for instruments and equipment that will last. The tracing paper they draw on must be permanent. Their drawings must serve as lasting records. They may even have to use these same drawings years later to make new reproductions.

For 79 years there has been a lasting partnership between Keuffel & Esser Co. equipment and materials and the engineers and draftsmen of America. This partnership has been so general, that there is scarcely an engineering or construction project but what K & E products have played their part in it.

One of these products is ALBANENE* Tracing Paper. Its 100% pure white rag fibers are stabilized and transparentized with Albanite, a K & E synthetic solid. ALBANENE is permanent. Free from oils, it cannot "bleed" nor lose its transparency with time. For complete details, write to your nearest K & E distributor or to Keuffel & Esser Co., Hoboken, N. J.

*Reg. U. S. Pat. Off.

K+E

Drafting, Reproduction, Surveying Equipment and Materials. Slide Rules, Measuring Tapes.

KEUFFEL & ESSER CO.

EST. 1867

NEW YORK • HOBOKEN, N. J.

CHICAGO • ST. LOUIS • DETROIT • SAN FRANCISCO
LOS ANGELES • MONTREAL

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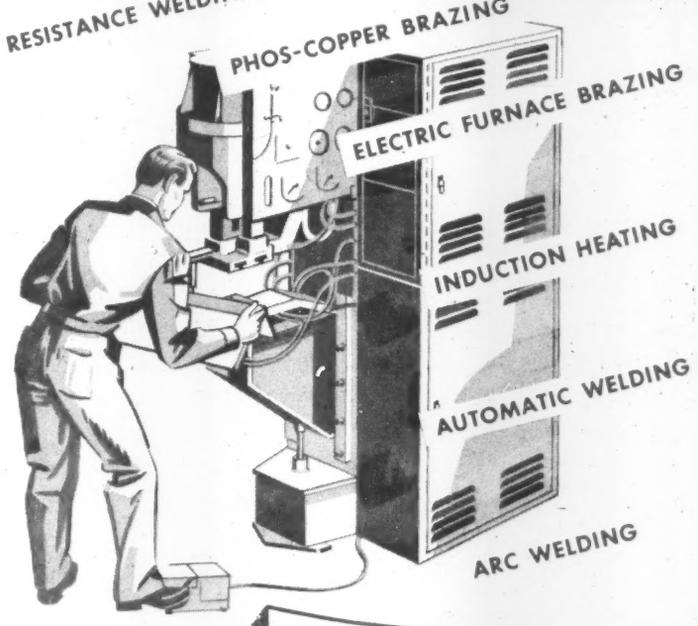
Use these ***IMPROVED***

METAL-JOINING METHODS

TO PRODUCE *BETTER* • *FASTER* • *CHEAPER!*



Approximately 20 percent of all production costs in American factories can be attributed to metal-joining. So, here is an important operation to examine for possible application of improved production equipment and methods.

Westinghouse manufactures most types of metal-joining equipment—and has gained the experience of applying this equipment in a wide range of industries, as well as in its own manufacturing operations. Whatever your metal-joining problem, Westinghouse can provide the *right* equipment and methods to perform nearly any job.

On the next two pages are examples of seven *proved* production methods, already working in many plants. Any one of them may help you turn out your products *better . . . faster . . . cheaper!*

FOR EXAMPLE **. . . If you assemble small parts in your plant:**

1. Must you increase production and cut costs in joining sheet metal?
2. Do you need a mass-production method of joining small but heavy metal pieces of uniform sizes?
3. Are castings slowing down your production . . . by slow deliveries, rejections, weight or bulkiness?
4. Do you need a quick and cheap method of joining copper or copper-alloys without the use of flux or acid?

For answers to questions like these . . . turn the page

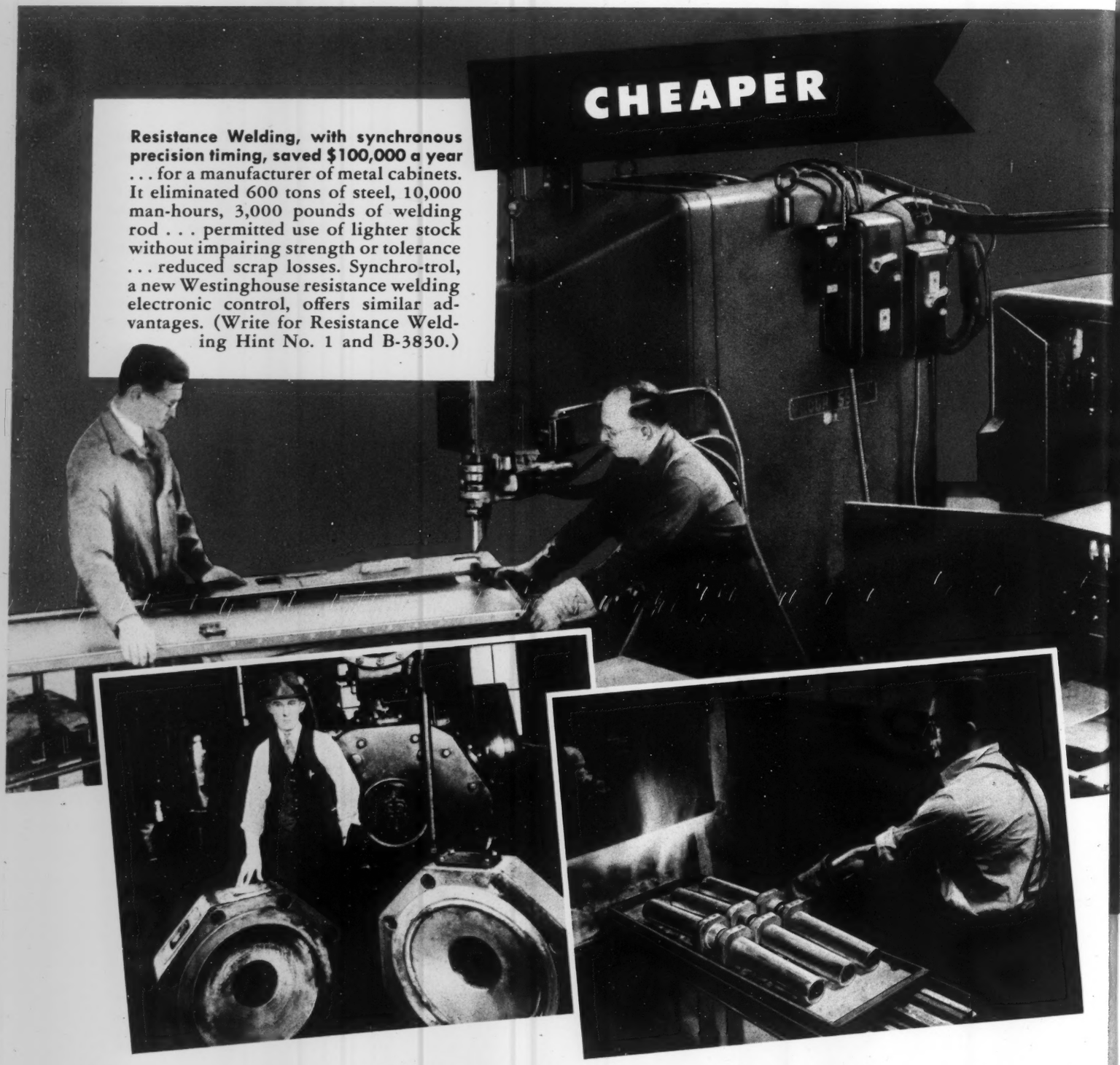
WESTINGHOUSE

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Investigate these PROVED METAL-

TO CUT COSTS, SAVE TIME,



Resistance Welding, with synchronous precision timing, saved $100,000 a year . . . for a manufacturer of metal cabinets. It eliminated 600 tons of steel, 10,000 man-hours, 3,000 pounds of welding rod . . . permitted use of lighter stock without impairing strength or tolerance . . . reduced scrap losses. Synchro-trol, a new Westinghouse resistance welding electronic control, offers similar advantages. (Write for Resistance Welding Hint No. 1 and B-3830.)

$85.00 savings per unit by A-C Arc Welding . . . when this company switched from casting cylinder heads to welding them of ¾" boiler plate. Results: *better, stronger* cylinder heads . . . and *200 pounds of weight eliminated.* (For more information, write for B-3548.)

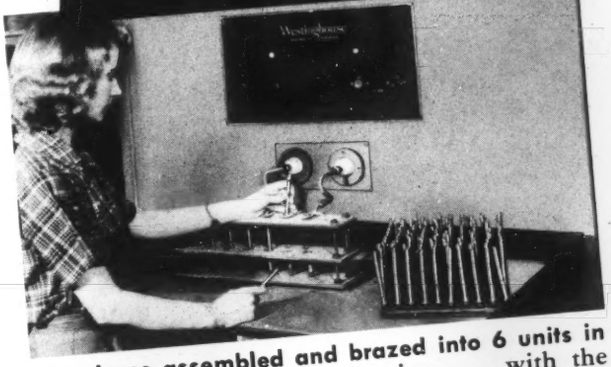
Electric Furnace Brazing cut factory costs 52% on this pump muffler by brazing separate baffles to the outer shell, instead of casting the unit as a single piece. (For equipment details, write for descriptive data DD-28-140, 28-450, 28-460.)

JOINING METHODS

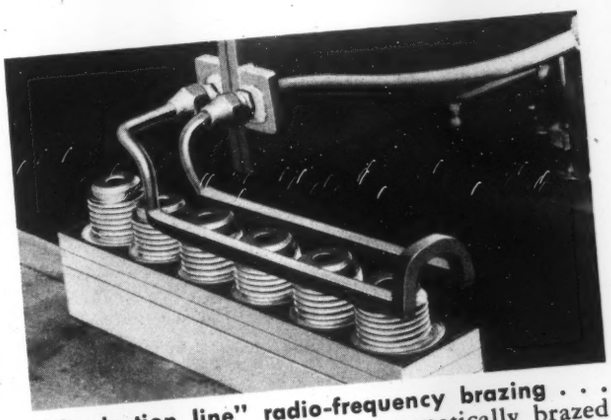
IMPROVE PRODUCTS

Here are seven examples of metal-joining that have helped make products better, faster, cheaper. Each is a potential cost-cutter for you. For more detailed information on any of these metal-joining methods—call your Westinghouse office.

FASTER

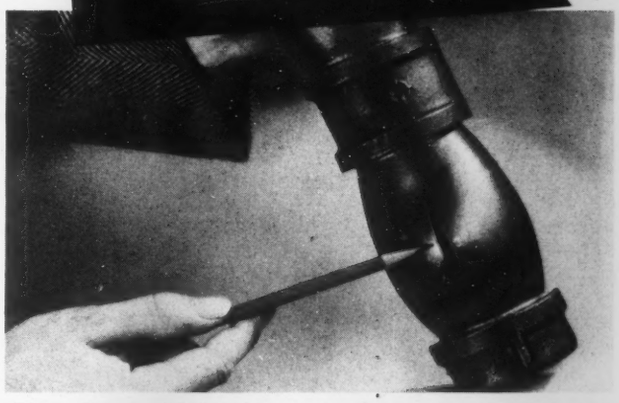


18 pieces assembled and brazed into 6 units in 7 seconds by induction heating . . . with the aid of a simple jig. The normal method of flame brazing this steel tube assembly required two minutes to complete *one assembly of three pieces.*

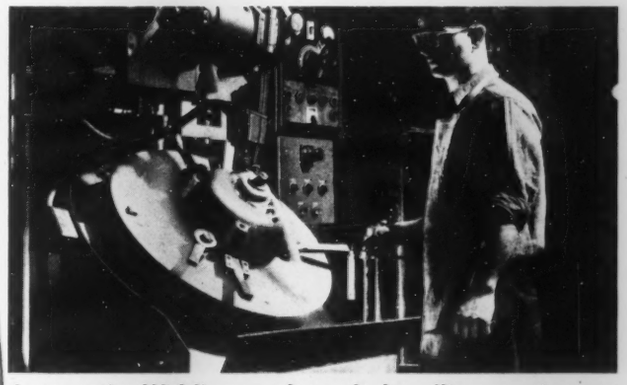


"Production line" radio-frequency brazing . . . these copper bellows are automatically brazed as a conveyer carries them through the work coil. Apparatus: radio-frequency generator, work coil and conveyer. (Write for B-3620.)

BETTER



Phos-Copper joints improved pressure resistance of joints as shown by this pressure test photo. The joints between the bronze caps and copper tube were still tight and sound when the tube burst at 2,200 psi. (Write for B-3201.)



Automatic Welding and work handling equipment . . . in motor manufacture reduced frame size 35% . . . increased power capability 116% per pound . . . tripled production. For further information, call your nearest Westinghouse office.

FOR MORE PRODUCTIVE POWER...LOOK TO

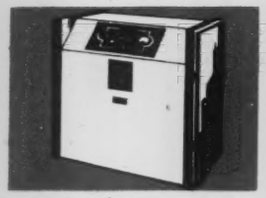
Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

HERE'S THE COMPLETE LINE OF WESTINGHOUSE METAL-JOINING EQUIPMENT

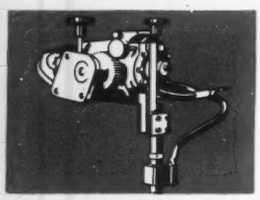
FOR ANY METAL-JOINING PROBLEM Westinghouse OFFERS YOU

THE RIGHT EQUIPMENT..APPLICATION HELP

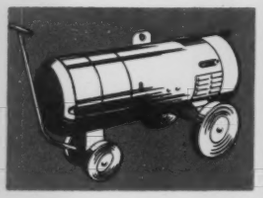


R. F. Heating Generators are built in ratings of 5, 10, 20, 50, 100 and 200 kw for induction heating. Work handling equipment available for all metal-joining applications.

A-C Arc Welders range from 100 to 2,000-ampere capacities to handle everything from lightweight, mass-production welding to heavier structural and fabrication welding.



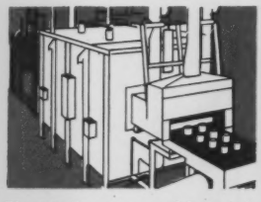
A-C Automatic Welding Heads—feed electrodes to the work continuously at an accurately controlled rate. Unit automatically starts and stops. Ideal for mass production.



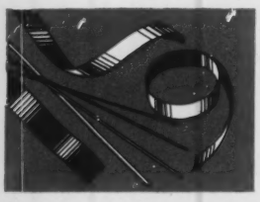
D-C Flexarc Welder... Single operator, portable or stationary motor or engine-driven sets. Available in maximum ranges up to 200 amp, 300 amp, and 400 amp.

Resistance Welding Controls... SYNCHRO-TROL and WELD-O-TIMER . . . available for synchronous and nonsynchronous operation. Combinations to meet special needs.

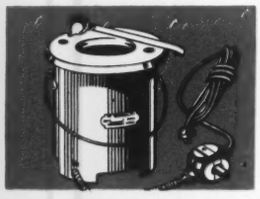
Electrodes and Accessories . . . a complete range of electrodes for every type of welding, and all accessories needed—for both machine and operator.



Electric Furnaces—20 models for brazing and heat-treating metals. Five basic types of gas atmosphere generators also available, providing nine varieties of gases.



Phos-Copper is manufactured in rod, ribbon and special shapes which are particularly useful in torch, resistance, furnace and induction brazing. For copper alloys only.



Solder Pots... 10-pound and 50-pound solder capacity. 3-heat snap switch (on 10-pound size) with temperature range up to 950°F. Fully insulated.

APPLICATION ENGINEERING

Westinghouse Application Engineering Service is available to help solve metal-joining problems in your plant. Broad industrial experience gained in our own and customers' manufacturing operations is yours for the asking.

RESEARCH

The scope of Westinghouse research reaches into every industry. Wherever power is used and distributed, this research has played an important role in doing jobs *better, faster, cheaper.* Westinghouse research facilities are available at any time to help you use new production tools and apply scientific knowledge in finding practical solutions to production problems.

TRAINING MATERIAL

Westinghouse training material covers instruction courses in such subjects as electronics and resistance welding, radio-frequency heating and arc welding. It also includes everyday help in all phases of the operation and maintenance of modern electrical equipment. This help is available in the form of *printed literature* and *training films.* Ask your Westinghouse office for full information.

MAINTENANCE

A nationwide organization of 34 Westinghouse Manufacturing and Repair Plants offers speedy, effective help on all types of electrical service and repair. A skilled staff of specialists, available through your near-by Westinghouse office, is ready to help you at any time.

J-90569

Mail this coupon for more information

Westinghouse Electric Corporation
P. O. Box 868, Pittsburgh 30, Pa.

Please send me more information on the following products:

____R. F. Heating	____D-C Welding	____Electric Furnaces
____Resistance Welding	____Automatic Welding	____Solder Pots
____A-C Welding	____Electrodes and Accessories	____Phos-Copper

Name_____ Company_____

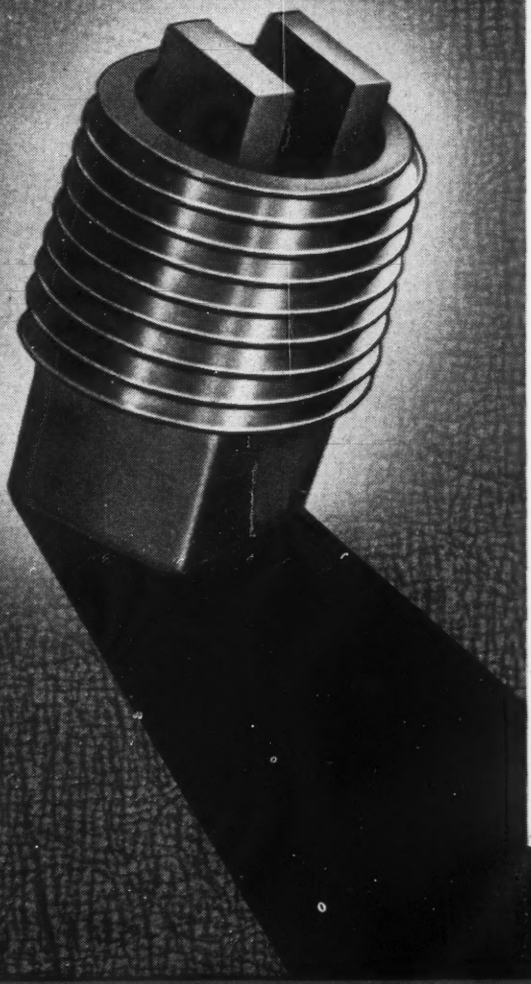
Title_____

Address_____ City_____ State_____

PRODUCTIVE POWER

Litho in U. S. A.

Reduce Wear with Lisle MAGNETIC Plugs



Permanent Protection for Bearings

Bearing failures are often caused by the abrasive action of iron and steel particles in the lubricant. When Lisle Magnetic Plugs are used in place of ordinary drain or oil level plugs, the powerful magnet in the Lisle Plug stops this damage by catching and holding these destructive particles. Your product deserves this positive, low-cost protection. Write for details, prices, and sample plugs to test in your product.

Lisle Magnetic **PLUGS**

Manufactured by LISLE CORPORATION
Box 1003 Clarinda, Iowa

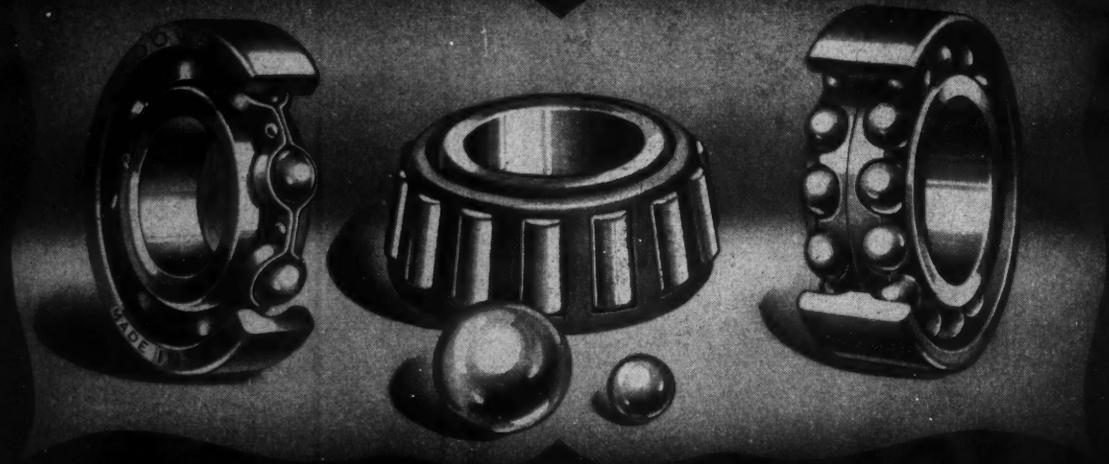
The Aristocrat of *Bearings*

FOR THOSE WHO BUILD

AMERICA'S FINEST EQUIPMENT

AND *Demand*

THE FINEST BEARINGS

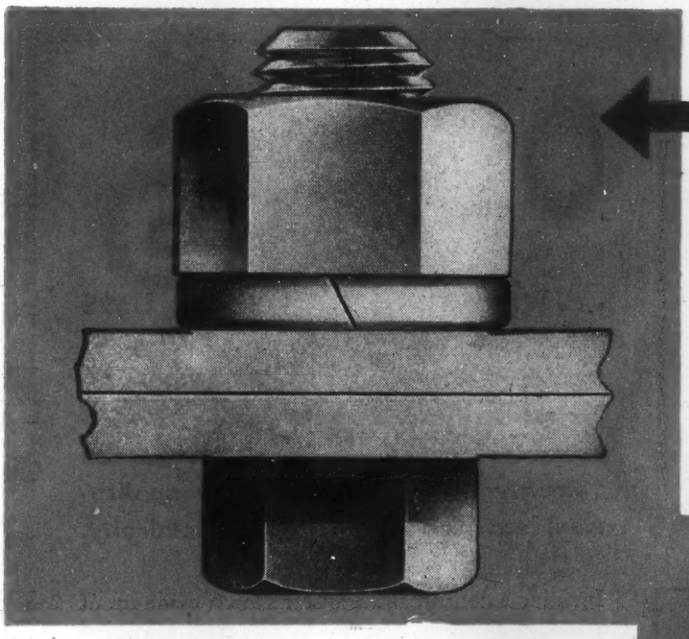


HOOVER

The World's Only Ball Bearing with Honed Raceways

HOOVER BALL AND BEARING COMPANY -- ANN ARBOR, MICHIGAN

For REAL Bolted Security... A SPRING Washer is a MUST



BEFORE WEAR

(Kantlink Compressed)

IT'S TIGHT

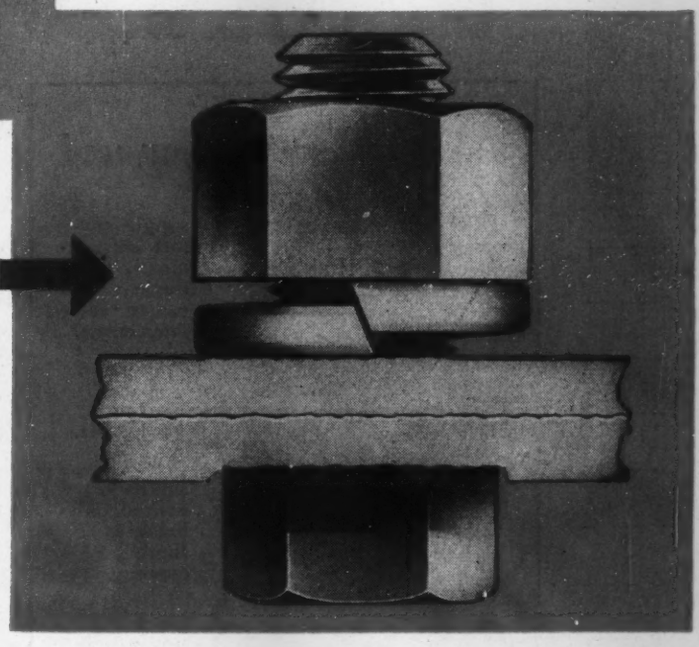
because you wrenched it TIGHT

AFTER WEAR

(Kantlink Expanded)

IT'S STILL TIGHT

because the Spring Washer expanded and held all parts Tight



Originators of KANTLINK the long-range spring washer

Since the advent of the castellated nut—a fixed nut—research has found that eventual looseness in bolted assemblies will be caused by the ductility of metal—by bolt stretch—and by inevitable wear at every contact point of metal surfaces.

Nut locking devices—although they may keep the nut from turning—do not and can not give the necessary spring action that keeps other parts of bolted assemblies tight. Vibration and stress loosen everything—they always have, and always will.

You should use a strong spring washer that expands as wear occurs. Expanding spring action retards initial wear, and then compensates for later wear to hold all parts tight longer. Nothing but a live spring can do this essential job.

There is no substitute.

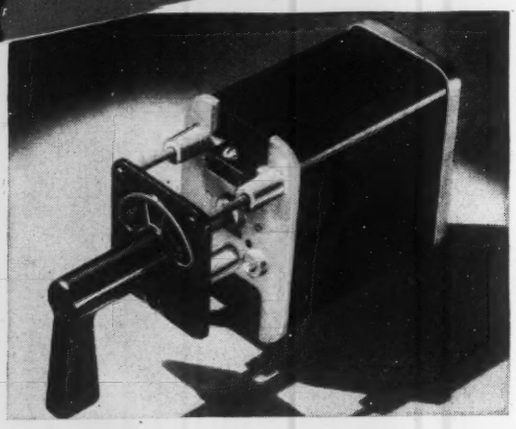
For real bolted security specify Kantlinks.

Send today for descriptive folders.

THE NATIONAL LOCK WASHER COMPANY

Newark 5, New Jersey — Milwaukee 2, Wisconsin

DESIGNER'S *Digest*



ONE SWITCH

...with more than 7000 uses

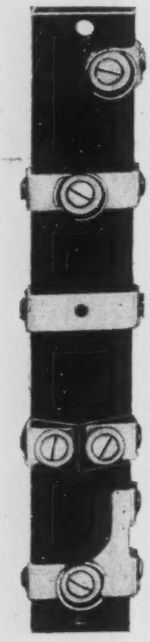
For applications up to 600 volts, 20 amperes — from ON-OFF to complicated-sequence switching — you can get an "exactly right" switch for any application, easily, quickly and economically.

Imagine a control and transfer switch made up of standard parts, yet so flexible in its application that designers have used it in more than 7000 different arrangements! That's the G-E Type SB-1 switch.

For ordinary control jobs, you specify the ordinary type. On highly specialized applications, you still benefit from standardization. By using *standard* cams, contacts, fingers and other parts, we build you a "custom-made" switch to control practically any sequence of operations *and* at the price of a standard unit.

G-E control and transfer switches are designed and built for extra reliability and long service life. Important construction features are silver-to-silver contacts, anti-arcing barriers between adjacent circuits, sturdy Textolite face plates, and attractive switch handles. For complete details and contact possibilities, check Bulletin GEA-1631E.

Pick the contact type you need



Single-break contact	*for*	simple control arrangements, also staggered contact arrangements.
Two single-break contacts, center connection	*for*	single-pole, double-throw arrangements.
Two single-break contacts, in series	*for*	single-pole, single-throw with double-break interrupting capacity.
Two single-break contacts, separate connections	*for*	two-pole, single-throw arrangements.
Three single-break contacts, common connection	*for*	opening and closing a device with one circuit.

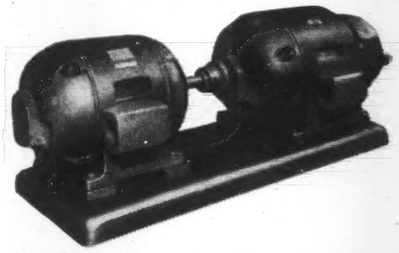
For Extra Heavy Duty Service!

When you need a control switch to perform many thousands of repetitive operations per week, use a unit that has extra strength "built in" — G. E.'s master control switch, Type SB-9. Steel mills like the way it stands up to heavy circuit control jobs. Every part — contacts, gears, shunt connections, even handles are made extra strong to resist wear. Ask for Bulletin GEA-4114.

GENERAL ELECTRIC

High Speeds...

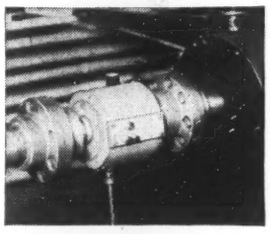
MADE EASY!



Many grinding and woodworking machines, as well as portable hand tools, have high-speed motors which require frequencies above the regular power supply. G-E induction frequency converters will supply 120, 180, 240, 360 and 420 cycles for these jobs. The converter is designed for constant excitation from a polyphase a-c supply and may be furnished alone or in combination with a driving motor. Ask your nearest G-E office for further information on induction frequency converters or frequency converter sets.

Tells pound-feet...

WITHOUT CRADLING!



This G-E electromagnetic torque meter is surprisingly easy to use. You simply couple the shaft unit between the load and the driving unit, start the machine, and take your readings. Cradling the load or fussing with scales is unnecessary. The meter measures torque directly without absorbing power from the load. This instrument consists of a shaft unit, oscillator, power unit, and indicating devices. Absolute accuracy within plus or minus 1 per cent of full-scale reading is provided. Check Bulletin GEA-4441A on coupon.

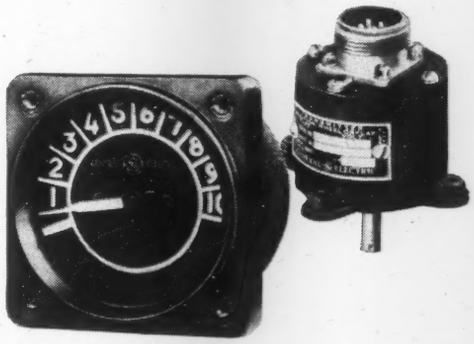
Better Welders...

TRAINED FASTER!

The war years proved the value of visual employee training methods. Output climbed, rejects dropped. Now G. E. has produced a new full-color sound movie that illustrates by animated sketches the principles and uses of three types of resistance welding — spot, projection, and seam. More than 100 applications are shown in fifteen different industrial plants. Accompanying the film is an interesting bulletin which reiterates the key points made in the film. The film, part of G.E.'s MORE POWER TO AMERICA program, is available for loan without charge from your local G-E office.

POSITIONS MADE CLEAR

...from remote stations!



Thousands of military aircraft found one or more uses for G-E position-indicating equipment. Many of the jobs called for high accuracy and complete reliability in remote transmission of position signals. Now G. E. believes that industrial designers can take advantage of this wartime development. To that end, our engineers are ready to help you investigate application possibilities on your machines, large or small.

One of the new position-indicating arrangements perfected by G. E. is a d-c selsyn three-wire system. Transmitters will operate in an ambient temperature range from −85 F to 158 F and are weather resistant. Indicating instruments are available in two standard sizes — 1⅞-inch dial with 1 or 2 pointers and 2¾-inch dial with 1, 2, 3, or 4 pointers. Dial markings are made to meet your requirements.

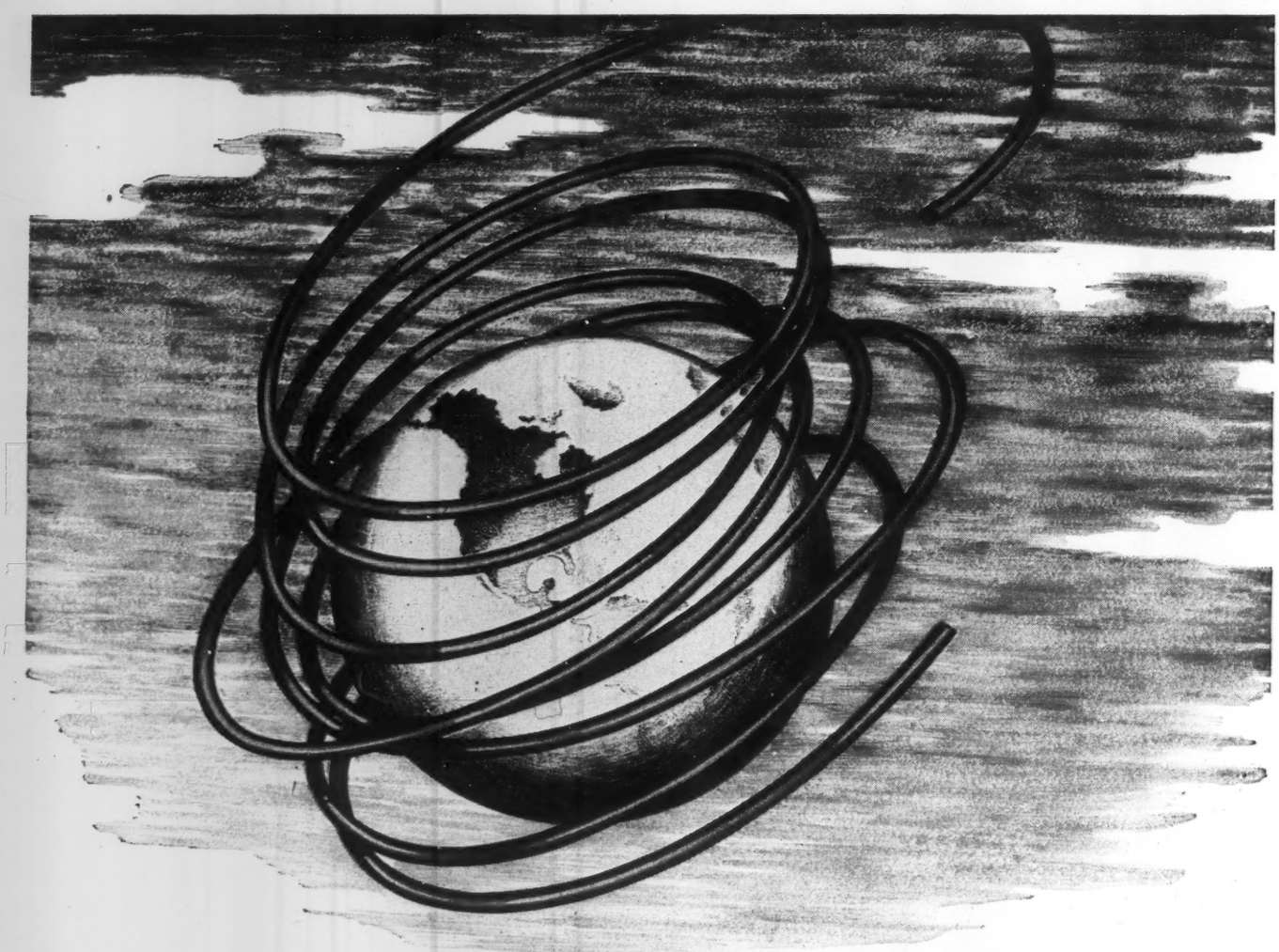
A single d-c selsyn indicating system consumes about 2 watts at either 12 or 24 volts. Any reasonable lead length may be used. Two indicating instruments can be operated from the same transmitter. Bulletin GET-1304 is a comprehensive application manual you'll find extremely helpful. Check it on the coupon.

TO GENERAL ELECTRIC COMPANY
Section B668-54, Schenectady 5, N. Y.
Please send me the following information:

_____GEA-1631E (Control and transfer switches)
_____GEA-4441A (Torque meter)
_____GEA-4114 (Master control switches)
_____GET-1304 (Position-indicating system manual)

Name _____
Company _____
Street _____
City _____ State _____

CONSULT YOUR SWEET'S! You'll find "everything electric" for machinery manufacturers in the General Electric section. 8579



ENOUGH TO GO 'ROUND?

Yes, *figuratively* we produced enough seamless non-ferrous tubing during 1946 to go 'round—enough to go 'round the world 7½ times (1,002,546,887 ft.). But *literally*, we haven't yet caught up with demand. Every day we tell customers "Sorry, we don't know when we'll ship your order". We realize that a few lengths of copper or brass tubing can delay that new refrigerator ordered so long ago, or prevent completion of a new home. Everyone at Wolverine recognizes these responsibilities.

Throughout 1946 our men and machines operated 24 hours each day—six days each week—in order that production might continue its climb. Even with the production records we have attained in the past few months, there is still not enough tubing to go 'round.

A lot of thanks belongs to you who have waited patiently. We sincerely appreciate the confidence you have placed in us, and you can be sure that we will continue to produce as much tubing as possible every day, and still maintain our quality control.

Soon there'll be enough Wolverine copper and brass tubing to go around and we'll be able to fill your needs more promptly.

WOLVERINE TUBE

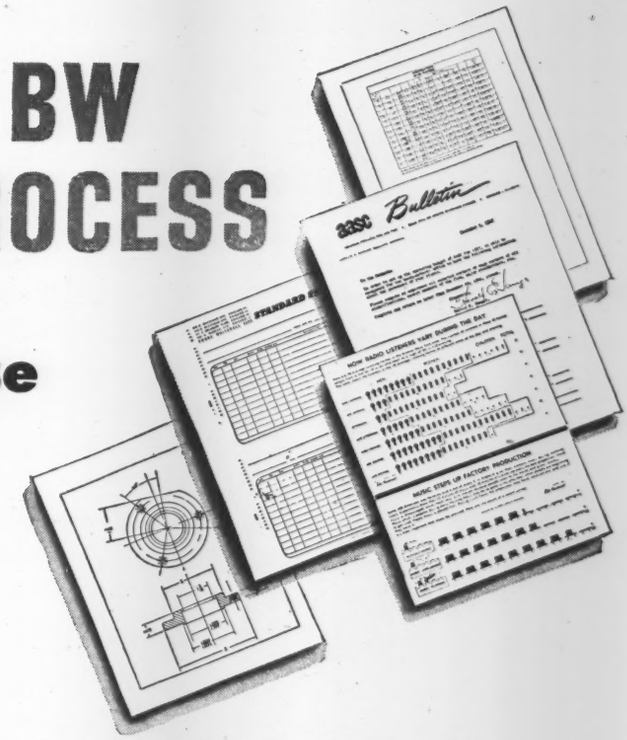
WOLVERINE TUBE DIVISION

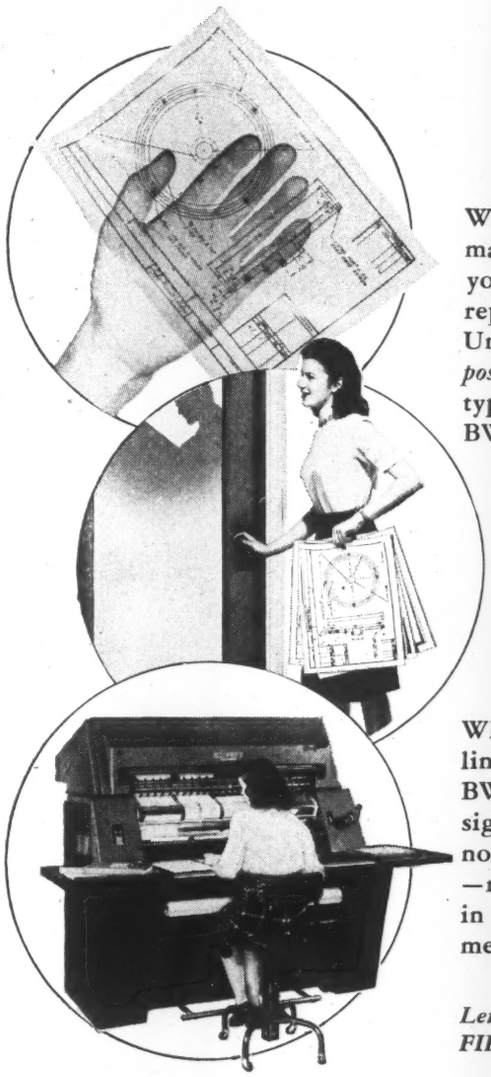
Calumet & Hecla Consolidated Copper Company

1411 CENTRAL AVENUE • DETROIT 9, MICHIGAN

BRUNING BW PROCESS

makes reproducing these as simple as this...





When you type, print or draw forms—bulletins—charts—graphs—maps—make them on translucent or transparent materials. Then you can reproduce them in unlimited quantities—just as engineers reproduce tracings—with the BW Direct Line printing process. Unlike blue prints, which are negatives, BW Prints are direct line *positive* prints, easy to read and check. Any additional information typed or written on the original will be reproduced on the duplicate BW Print.

One operator, using a BW Printer-Developer, can produce prints from your originals in seconds! What's more, your prints can be made on regular weight, thin or card-weight BW paper—with black or colored lines on white backgrounds—with black or colored lines on pink or green tinted backgrounds—on transparent paper, on film or on cloth.

Why should you choose BW? Because Bruning provides a complete line of printers and developers for every need. Because Bruning BW machines have no unnecessary gadgets—are especially designed for quick, easy operation. Because BW equipment produces no fumes which must be exhausted with expensive vents and blowers—requires no plumbing connections—can be installed anywhere in your drafting room, engineering record reproduction department, office or plant.

Let us tell you why so many users place the BW Direct Line Printing Process FIRST in preference. Mail the coupon for complete information.

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Chicago 41, Illinois

Gentlemen: I want to know more about Bruning BW Prints and equipment. Please send me information.

Name.....

Company.....

Street.....

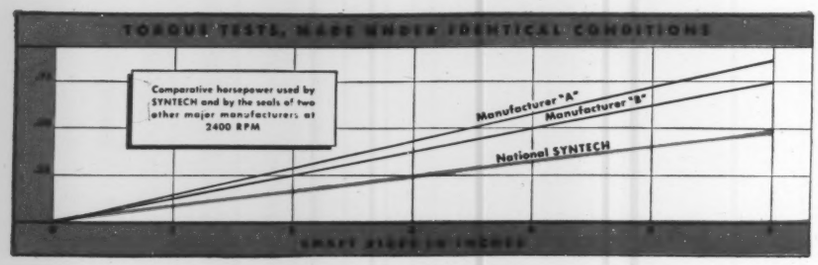
City.....*State*.....

Syntech*

New National Oil Seal slashes power-drag, yet provides zero leakage, longer life

Road and dynamometer tests have proven conclusively the superiority of these revolutionary new National Syntech Oil Seals. Tests show that Syntechs, with their precision-molded, synthetic-rubber sealing members, have a safety factor of speed, runout, abrasion and wear far greater than any other seal tested. National Syntechs perform at zero leakage over periods up to 10 times the life of an ordinary seal, thus blasting the theory that seals must operate at some leakage to achieve long life. These optimum results are obtained with a marked reduction in power-drag, as shown in the torque chart on this page. In some cases, this reduction is of the order of 70%.

National Syntechs can be supplied in any size, for any operation. For information and samples appropriate to your sealing problem, write today! There is no obligation, of course.

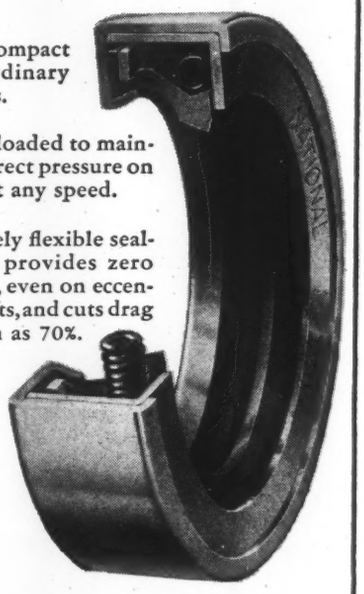


SYNTECH (trademark registered) is an entirely new oil seal which utilizes a special National-developed, synthetic-rubber sealing member.

1 More compact than ordinary oil seals.

2 Spring-loaded to maintain correct pressure on shafts at any speed.

3 Extremely flexible sealing lip provides zero leakage, even on eccentric shafts, and cuts drag as much as 70%.



SYNTECH is made of synthetic rubber compounded to achieve high flexibility and low coefficient of friction.

Design of sealing lip provides limited shaft contact.

This thin section assures maximum flexibility of the sealing member.

Two Syntechs end serious power-drag in "free-running" tractor winch

This power-driven tractor winch, designed to be free-running when clutch and brake-band were disengaged, actually required efforts of two husky men to unwind tow cable from drum.

Most of the drag was traced to a pair of ordinary oil seals in the drum assembly, and so these seals were replaced with two National Syntechs.

These Syntechs were faced with three heavy-duty chores: keeping lubricant in, keeping dust and dirt out, and absorbing severe runout caused by operating conditions.

Almost immediately field reports told of outstanding success. The Syntech seals, with their thin, flexible sealing lips, reduced drag to the point where the cable could be unwound merely by dropping cable and tow-hook to the ground and driving the tractor forward. Weight of the cable was now all that was needed to unwind the disengaged drum readily.

Possibly your oil seal problem can be solved as simply and easily. But whatever the case, our National engineers are eager to assist with their years of experience in the field. Give us full details of your problem, so we can be of maximum help. All information will be kept strictly confidential.

NATIONAL MOTOR BEARING COMPANY, INC.
General Offices: Redwood City, California
Plants: Redwood City and Los Angeles, California; Van Wert, Ohio

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

CHICAGO
Room 2014 Field Building, Chicago 3
Phone: Central 8663-8664

DETROIT
Room 1026 Fisher Building, Detroit 2
Phone: Trinity 16363

MILWAUKEE
1717 E. Kane Place, Milwaukee 2
Phone: Lakeside 2838

SPRINGFIELD, MASS.
124 State Street, Springfield 3, Mass.
Phone: Springfield 2-1881

PHILADELPHIA
401 North Broad Street, Philadelphia 8
Phone: Bell-Walnut 2-6997—6998

NEW YORK CITY
122 East 42nd Street, New York City 17
Phone: Lexington 2-8260

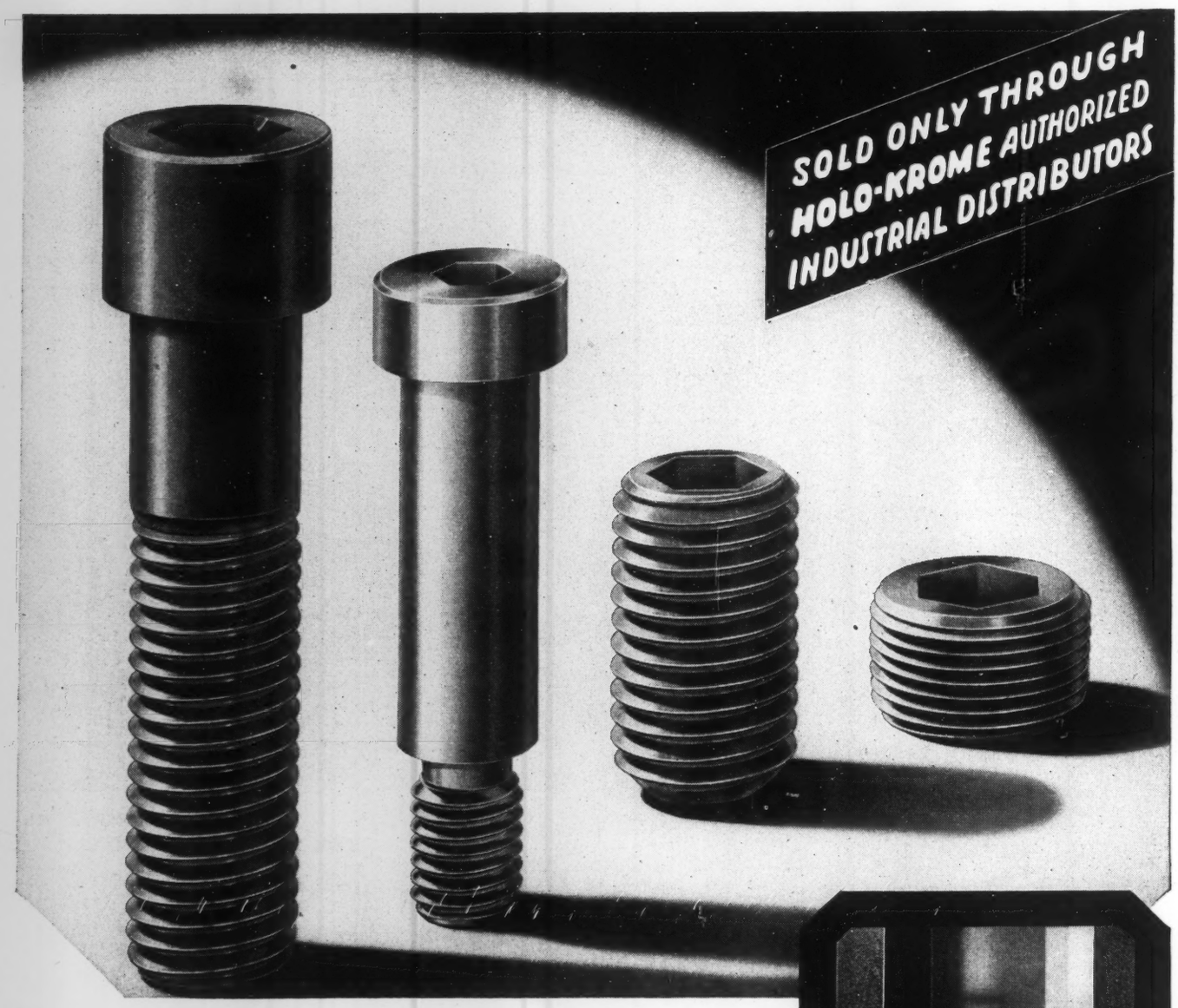
CLEVELAND
210 Heights Rockefeller Building, Cleveland 18
Phone: Yellowstone 2720

HOUSTON
1 Main Street, Houston 2, Texas
Phone: Preston 9862

KANSAS CITY, MO.
1823 Walnut Street, Kansas City 8, Mo.
Phone: Harrison 6637

NATIONAL
OIL AND FLUID SEALS

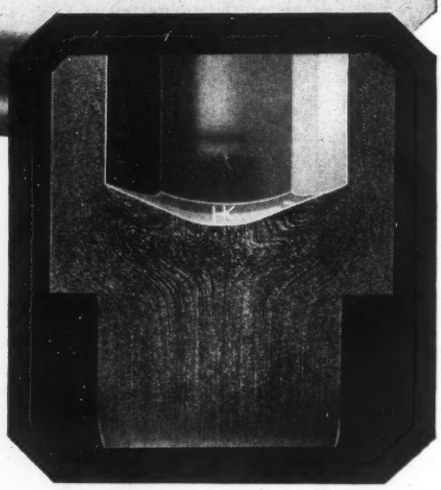
WHEREVER SHAFTS MOVE, THERE'S A NATIONAL SEAL TO RETAIN THE LUBRICANT



Completely Cold Forged QUALITY

Holo-Krome Fibro Forged Socket Screws are made by an exclusive Holo-Krome patented method whereby the Head and Body, in fact, all portions of the screw (threads excepted) are Completely Cold Forged. Fibro Forged Screws inherently have the completely continuous fibrous structure that results in increased strength. Specify "Holo-Krome" for Guaranteed Unfailing Performance.

THE HOLO-KROME SCREW CORP. HARTFORD 10, CONN. U. S. A.



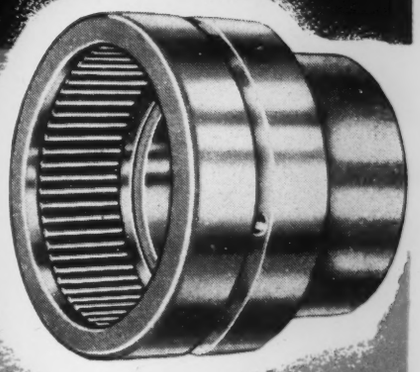
The unretouched etched cutaway view of a Holo-Krome Socket Head Cap Screw . . . Notice the CONTINUOUS FIBRES.

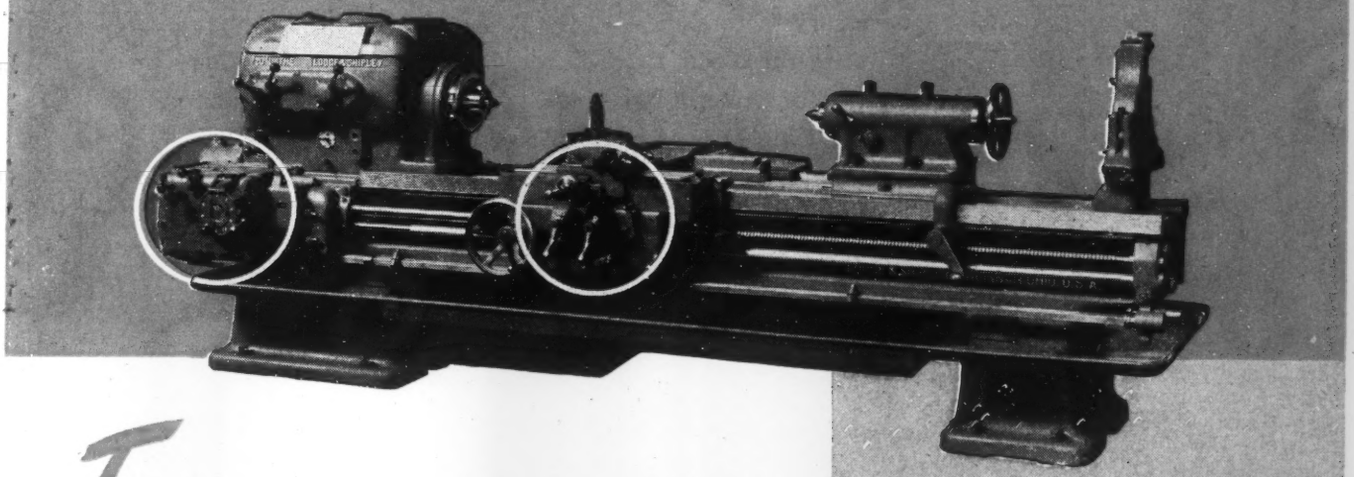
No. 04

HOLO-KROME fibro forged SOCKET SCREWS

ORANGE ROLLER BUSHINGS

provide smooth, precision operation in the Quick Change Gear Box and Apron of LODGE & SHIPLEY 20" ENGINE LATHES





THE above application is another of the many well-known installations where Orange Roller Bushings are serving with great success . . . maintaining precision running—meeting compact space requirements—giving years of anti-friction protection at critical wear spots.

Outstanding among the many advantages of Orange Roller Bushings is the high load carrying capacity in close quarters, permitting compact design. Precision manufacturing standards hold roller clearances to a minimum—result in closer running tolerances. This greatly reduces the possibility of misaligned rollers—assures smoother, quieter, trouble-free operation.

Give your equipment the anti-friction protection of Orange Roller Bushings. Available in a full range of sizes and types for most requirements. Write for Engineering Data Book giving design, dimensions, capacities, installation data, etc.

● Lodge & Shipley 20" Engine Lathes perform accurate turning, boring, facing, threading and tapering on a wide variety of precision parts. Despite this heavy service, Orange Roller Bushings —used in the Quick Change Gear Box and Apron—maintain true alignment and quiet, anti-friction operation in these important controls.

Mail Coupon for Engineering Data

Orange Roller Bearing Co., Inc., Orange, N. J. **M. D.**

Please send me your Roller Bushing Data Book.

Name.....Title.....

Company.....

Address.....

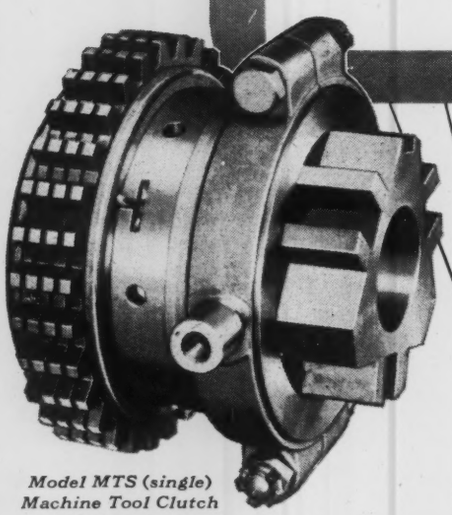
City.....State.....

ORANGE ROLLER BEARING CO., INC.
556 Main Street, Orange, N. J.

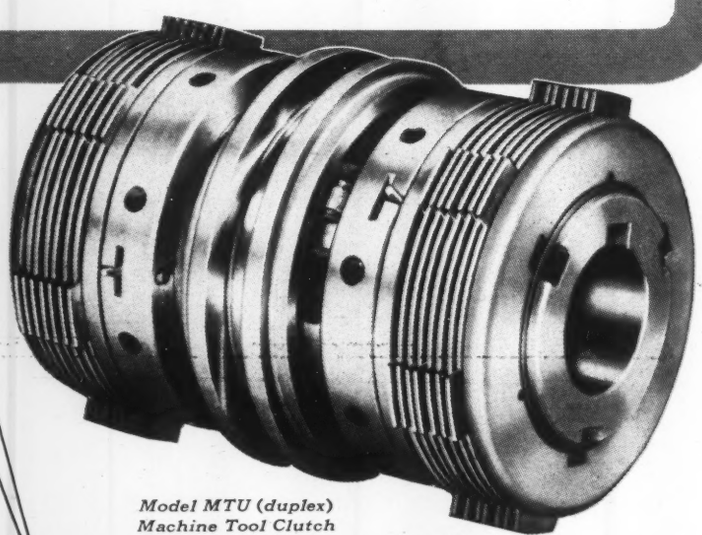
Smooth speed... easy accuracy

Smooth, easy engagement and quick positive release of your machine tool clutches are prime essentials if your precision work is to be accomplished with sufficient speed and accuracy to return a profit. Twin Disc Machine Tool Clutches are designed, built and applied to assure these necessary factors.

Write the Twin Disc Clutch Company, Racine, Wisconsin, for Bulletin No. 134A, which gives complete data on the Twin Disc Model MTS (single) and Model MTU (duplex) Machine Tool Clutches, both oil and dry types. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

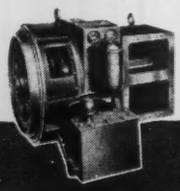


Model MTS (single) Machine Tool Clutch



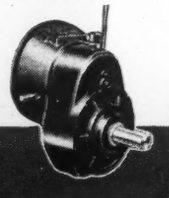
Model MTU (duplex) Machine Tool Clutch

Heavy Duty Clutch



Hydraulic Torque Converter

Hydraulic Coupling



Reduction Gear

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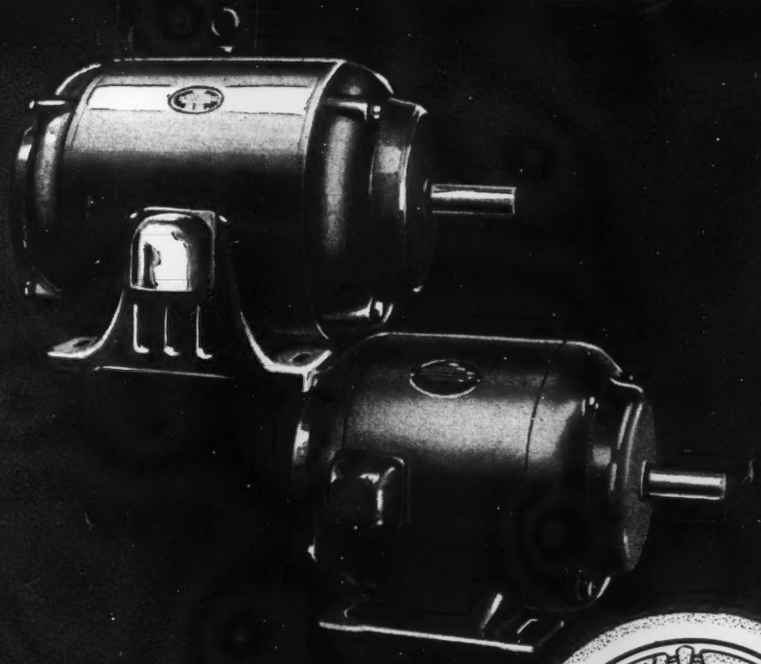

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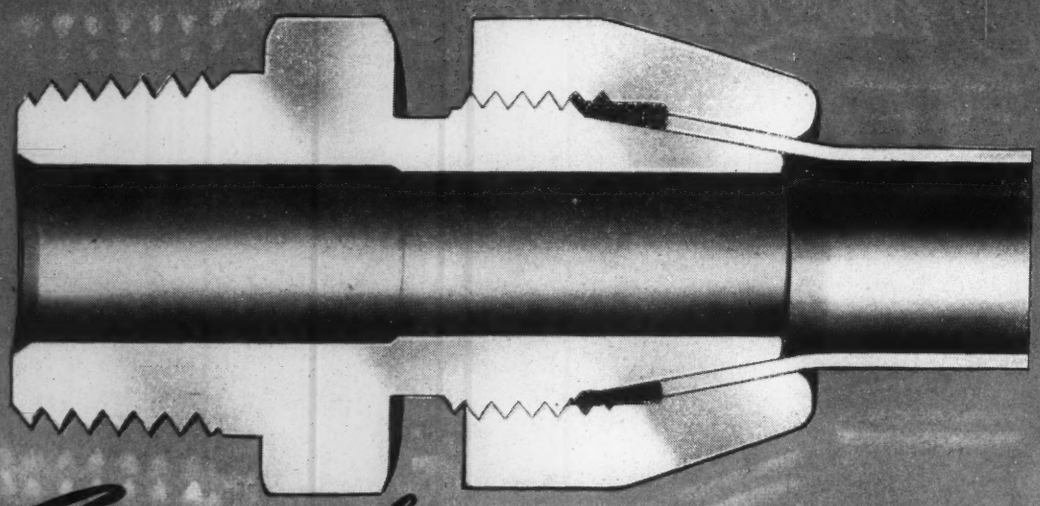
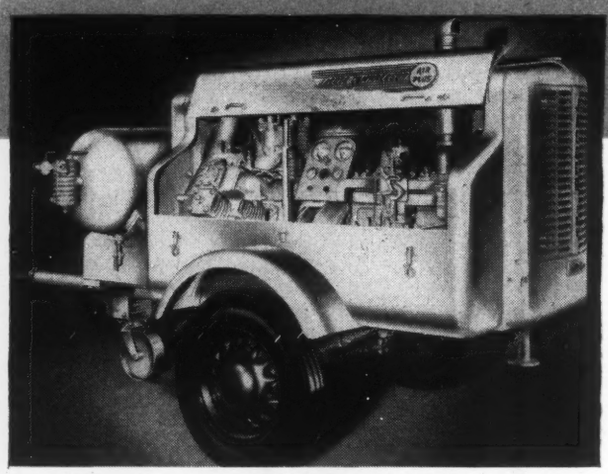


Superseal

FLARED TUBE FITTINGS



As a result of severe tests, Jaeger now standardizes on welded steel tubing and SUPERSEAL fittings for 4 sizes of compressors.

● Has the lack of a satisfactory fitting limited your use of light wall tubing where vibration and high pressure were present?

Then you will be interested in the findings of Jaeger Mfg. Co., which led to their standardizing on Superseal Flared Tube Fittings. Their test—running a compressor at full throttle for six hours at 600 lbs. pressure—proved that Superseal Fittings make a permanently leakproof joint unaffected by vibration, perform entirely satisfactorily with welded steel tubing using only a single flare. Fittings may be disconnected repeatedly without injury to the tubing.

Features of Superseal Fittings

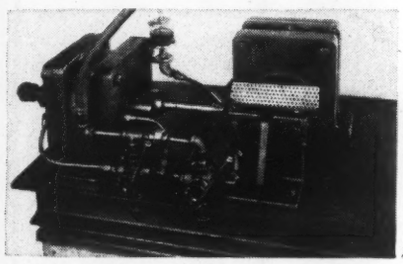
Long, smooth, tapered 10° flare on SUPERSEAL fitting and corresponding flare on inside of self-aligning nut hold tubing securely in place.

Materials: Stocked in brass and steel. Malleable iron, aluminum or alloys on order.

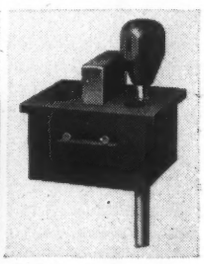
No shearing action to injure the tubing at the point of flare when the nut is tightened — the tubing is actually strengthened. Tubing bends can be made close to fittings.

Two part fitting . . . no rings, no sleeves.

Approved by Underwriters' Laboratories for all hazardous gases and liquids.



Production flaring of tubing up to 2000 flares a day is possible with this flaring machine.



Hand flaring of tubing of all sizes is easy with this simple tool.

Write for new catalog, 4-R "Grinnell Superseal Flared Tube Fittings".

GRINNELL COMPANY, INC.
Executive Offices: Providence 1, R. I.

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GRINNELL

FOUNDED 1850

WHENEVER **PIPING** IS INVOLVED

like skating on cinders!

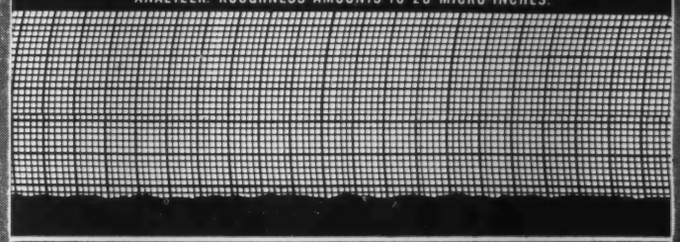
How long could rollers stand this? Not long . . . yet bearings must stand this same kind of punishment with a typical "finished" surface.

There it is, at the right, an actual profile of a normal ground surface as shown by the Brush Surface Analyzer. Look at those ups and downs, and you'll see why bearings wear out before their time.

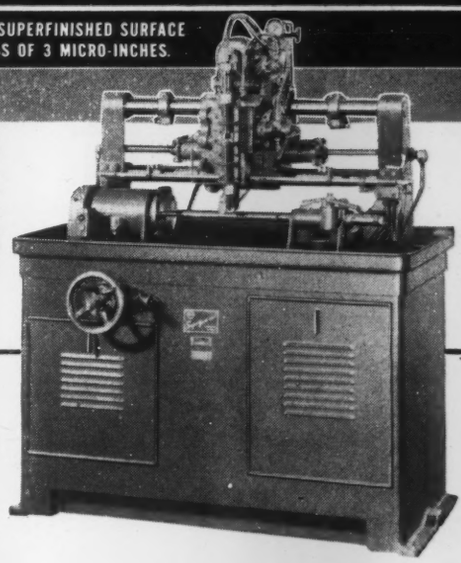
Now look below at the Brush analysis of a *Superfinished* surface. Smooth? Yes, *seven times as smooth* as the usual ground surface! No grinder scratches, no feed spirals, no chatter marks, no fragmented metal.

Without such defects to rupture the protective film of oil, the life of a bearing has no limit. So it pays to know about Superfinishing . . . and Gisholt engineers are ready with the facts.

NORMAL GROUND SURFACE AS IT APPEARS TO THE BRUSH SURFACE ANALYZER. ROUGHNESS AMOUNTS TO 20 MICRO-INCHES.



BRUSH ANALYSIS OF A SUPERFINISHED SURFACE SHOWS A SMOOTHNESS OF 3 MICRO-INCHES.

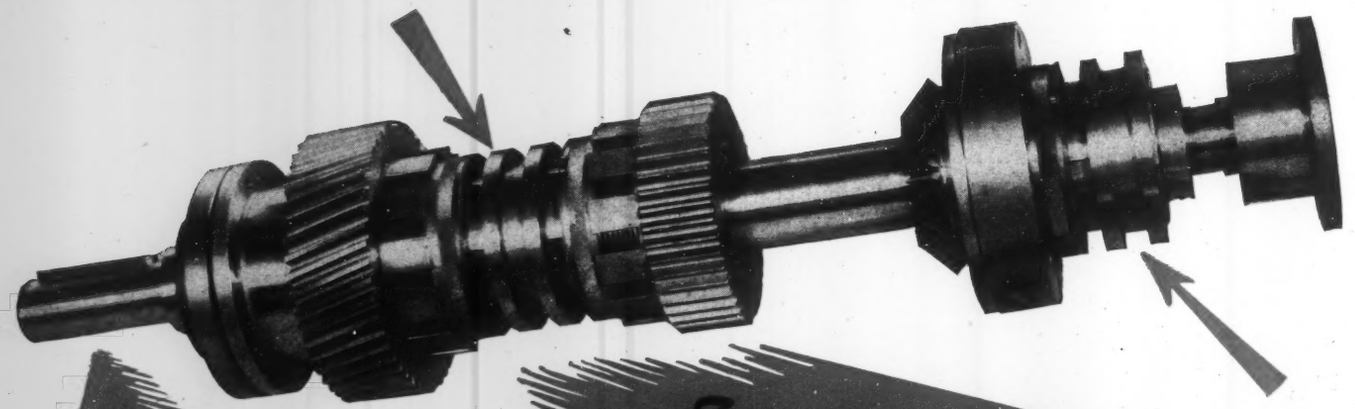


THE GENERAL PURPOSE SUPERFINISHER is a self-contained unit, simple to operate. Handles a wide variety of miscellaneous or production work. Also available — — specialized machines for all requirements.

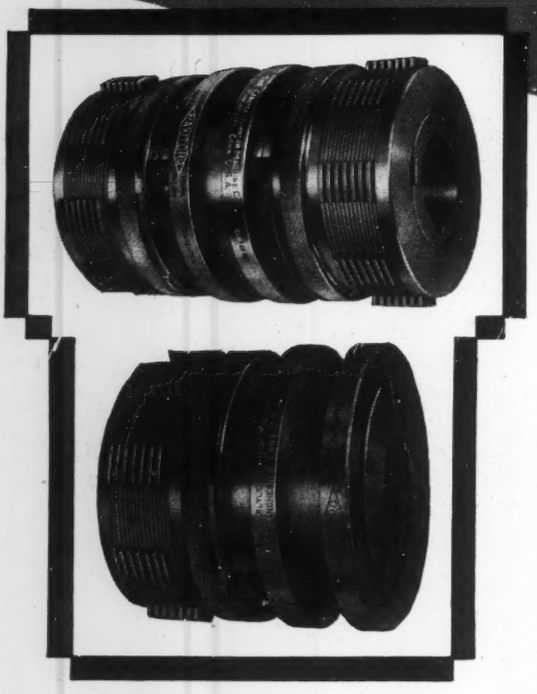
GISHOLT MACHINE COMPANY

1245 E. Washington Ave. • Madison 3, Wisconsin

THE GISHOLT ROUND TABLE
represents the collective experience of leading specialists in the machining, surface finishing, and balancing of round or semi-round parts. Your problems are welcomed here.



Single and Double
MAXITORQ CLUTCHES
SELECTED FOR THIS NATIONALLY KNOWN
MACHINE TOOL



Pictured above is the transmission assembly of an important new machine tool, showing how two Maxitorq Clutches are installed. They were selected after comparative tests by experienced machine designers.

So that you may judge the effectiveness of the Maxitorq . . . and consider its use for solution of your own power transmission problems, we present these outstanding features.

1. The Maxitorq is completely assembled on the clutch body and shipped ready to slip on a shaft.

2. NO TOOLS whatsoever are needed for assembly, adjustment or take-apart.

3. Separator Springs (patented) act, when the clutch is thrown into neutral, to separate the discs . . . you can see between them. Therefore there's no drag, no abrasion and no heating.

4. Disconnect is fast and positive . . . no slipping.

5. Clutch life is extended by means of specially finished flat, true engaging surfaces. Design is very compact, streamlined.

There are 8 sizes available, from ¼ to 15 H.P. at 100 r.p.m., in wet or dry type, single or double. Also pulley and cut-off coupling types.

In addition to the Standard Maxitorq we are now supplying an Automatic Overload Release type especially for use in high speed machinery that processes damageable or breakable products. Disconnect is instant . . . and automatic . . . a great protection to work and machine.

Please feel free to consult our Engineers on any problem within our field of power transmission.

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NEW CATALOG NO. MD5

THE CARLYLE JOHNSON MACHINE COMPANY
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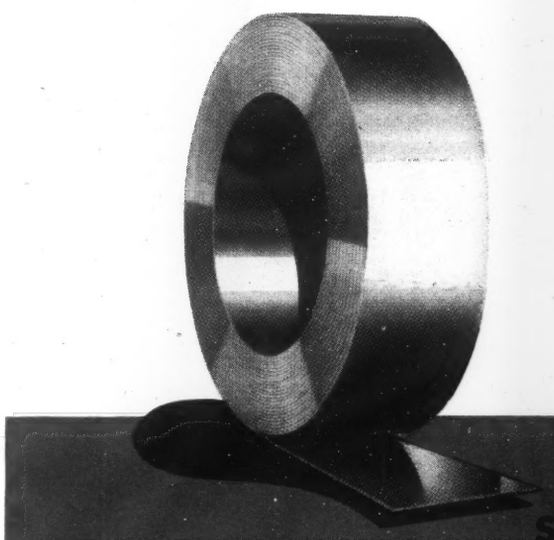
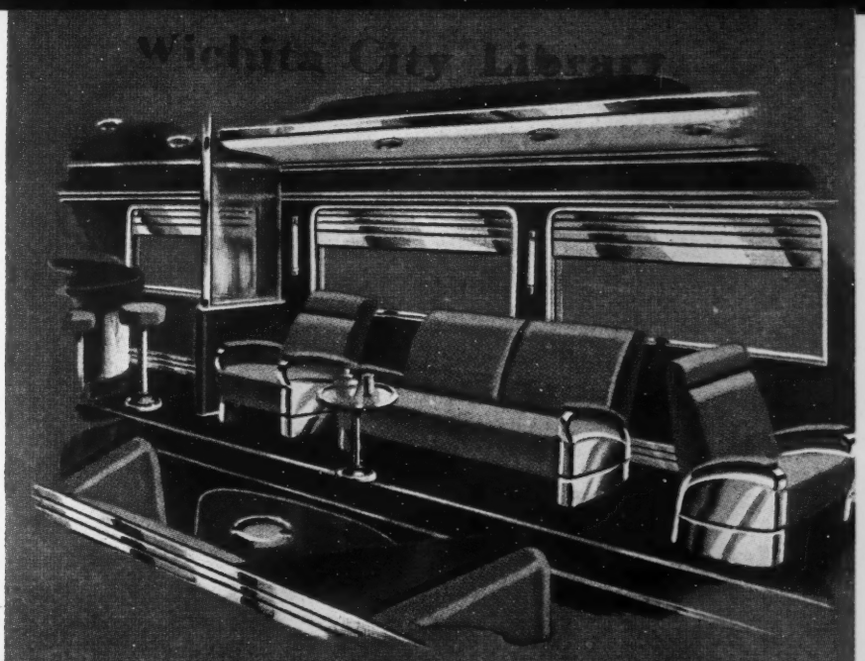
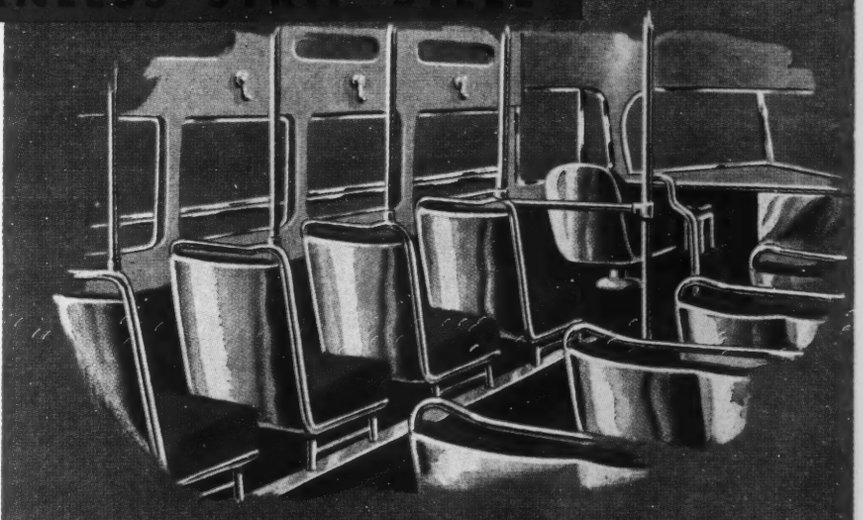




Superior
STAINLESS STRIP STEEL



The **RIGHT, BRIGHT** metal for transportation equipment

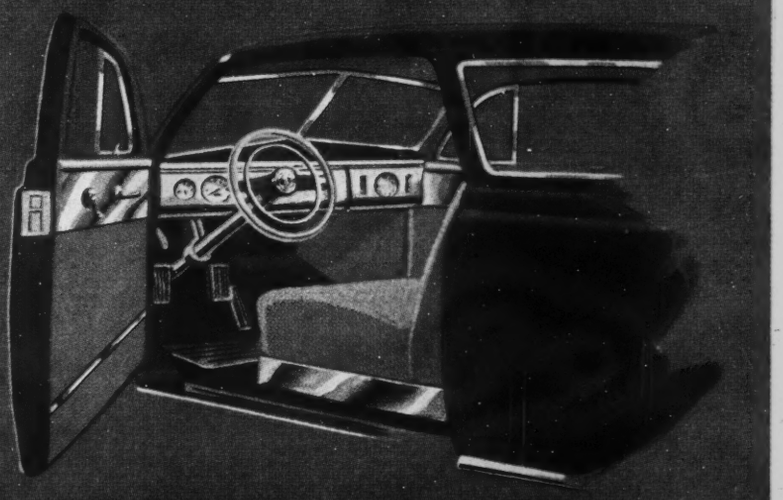
Everywhere in transportation—for permanent beauty or solid wear resistance—stainless steel is on the move. And moving smoothly through the stages of stainless equipment manufacture are bright ribbons of SUPERIOR Stainless Strip Steel . . . providing, through our specialized control of quality, outstanding handling ease for the fabricator . . . steel that is *"always on good behavior."* May we send you our comprehensive Stainless Brochure?

LUSTROUS

SOLID

PERMANENT

EASY TO FABRICATE

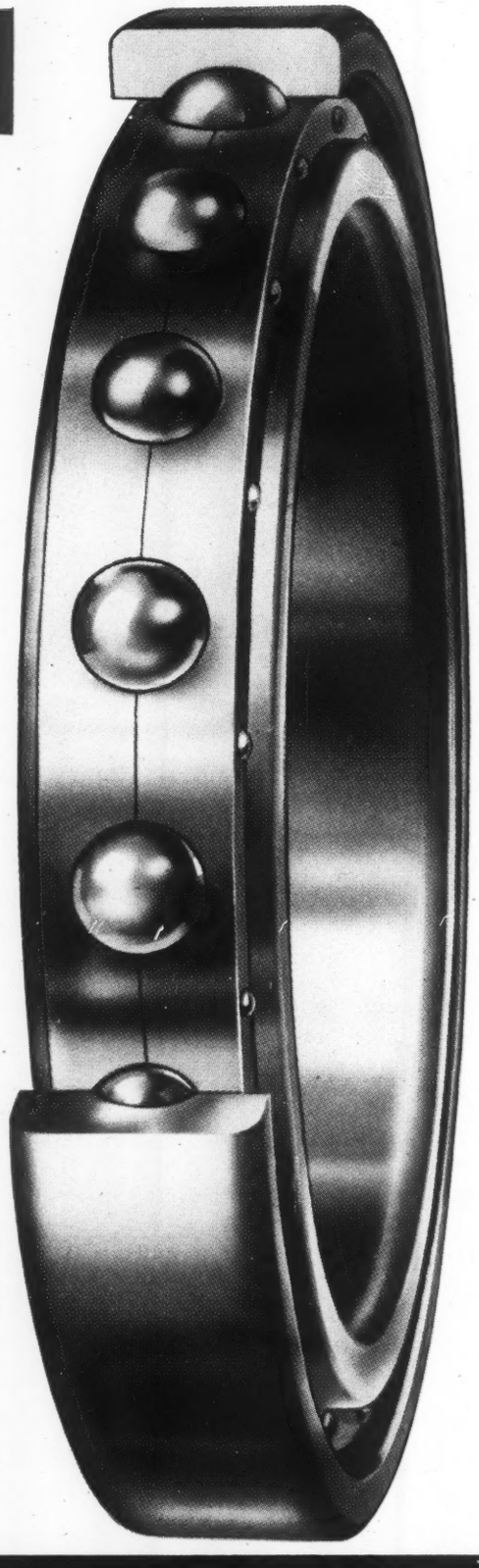


Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

BEARING FACTS NUMBER 5

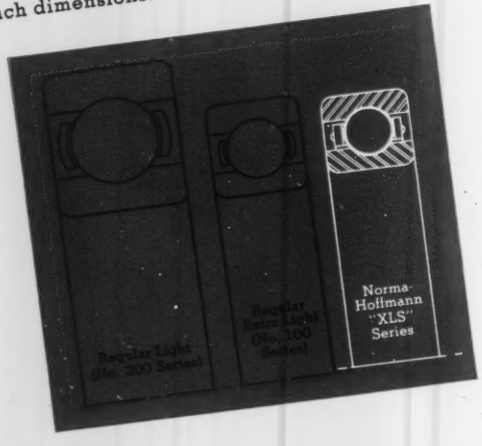
NORMA-HOFFMANN'S

Extra Light Ball Bearing



"XLS" Series Aids Designers Where Space is Limited

In many cases where friction-free operation must be had in extremely restricted space, these Extra Light Ball Bearings by Norma-Hoffmann have been the only solution. The "XLS" Series (in bore sizes below 1⅜" called the "S" Series) provides a range from ⅛" to 22½" bore. These bearings are self-contained, non-separable and are suitable for combined radial and thrust loads in either direction. They are made to inch dimensions.



FEATURES

1. Have unusually large bore compared to outside diameter.
2. Are compact, light in weight.
3. Allow greater latitude in design.
4. Provide utmost in accuracy, rigidity, load capacity and friction-free operation.

NORMA-HOFFMANN
Precision **BEARINGS**

NORMA-HOFFMANN BEARINGS CORPORATION
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"UNBRAKO" SOCKET SET SCREW WITH KNURLED CUP POINT

The knurled cup point of this "Unbrako" makes it a Self-Locker—the point digs in and holds fast, even when subjected to the most chattering vibration.

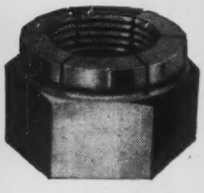
Pat'd. and Pats. Pend.

"UNBRAKO" SOCKET SET SCREW WITH KNURLED THREADS

The knurled swaged threads make this screw a Self-Looker, too, for Flat, Cone, Oval, One-Half and Full-Dog Points.

Pat'd. and Pats. Pend.

"FLEXLOC" SELF-LOCKING NUT



A Self-Locking All-Metal, One-Piece Nut. Every thread, including the locking threads, takes its full share of the load, and it sure does lock. Available in sizes #6 to 1" in diameter—millions in use.

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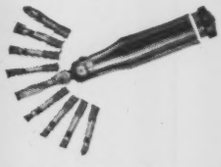
"HALLOWELL" KEY KIT



Kits. Pats. Pend.

You can't screw socket screws in or out without a hex socket wrench, so why not get our No. 25 or No. 50 "Hallowell" Hollow Handle Key Kit which contains most all hex bits.

Knurling of Socket Screws originated with "Unbrako" in 1934.

Reg. U. S. Pat. Off.

Reg. U. S. Pat. Off.

BY SPECIFYING UNBRAKO KNURLED SOCKET HEAD CAP SCREWS *YOU SAVE ASSEMBLY TIME*

The Knurled Head speeds assembly because it provides a slip and fumble-proof grip—though the fingers and head be ever so oily—therefore, you can screw it in faster and farther before it becomes necessary to use a wrench. The Internal Wrenching feature facilitates compact designs . . . reduces weight and costs. "Unbrako" Knurled Socket Head Cap Screws are available in sizes from #4 to 1½" in diameter and in a full range of lengths. Write for your copy of the "Unbrako" Catalog.

"Unbrako" and "Hallowell" Products are sold entirely through Industrial Distributors.

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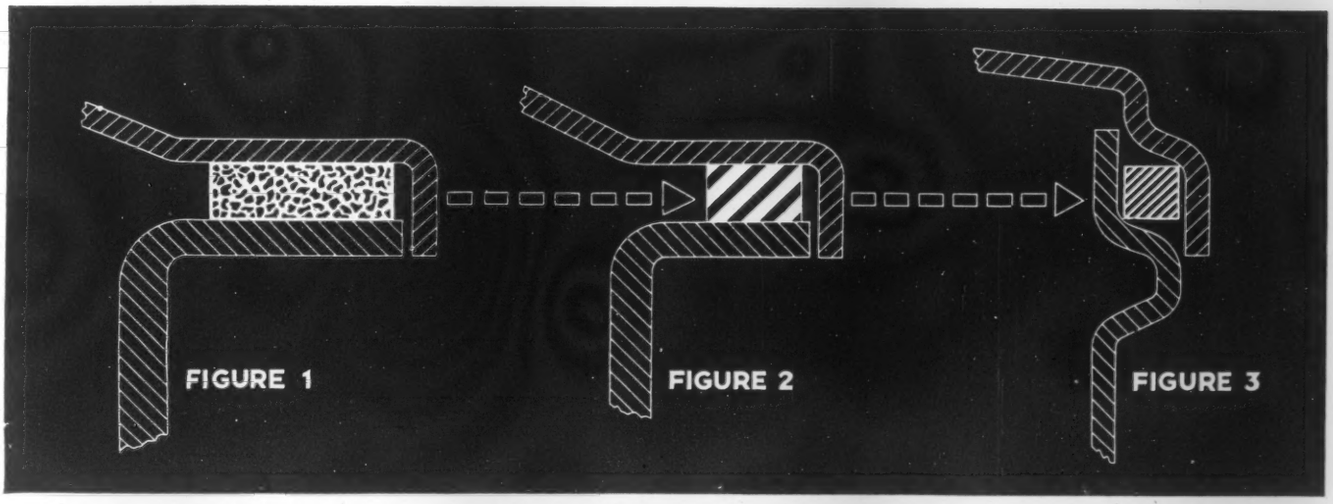


DESIGNING GASKETS TO REDUCE COST

Simple gaskets cost less yet often perform as well as complex molded parts

The most economical gasket has the least volume of material and the simplest shape consistent with application requirements.

To realize this ideal fully, joint design should be simple mechanically. Frequently such design simplification will permit the economic use of materials that offer longer life and a better safety factor. An example of progressive development in this respect is provided by an equipment manufacturer who first used a cork composition gasket.

That first gasket necessarily was bulky in cross section (Figure 1). To reduce flange size and at the same time improve gasket life, one of Armstrong's cork-and-synthetic-rubber gasket materials was tried (Figure 2). This gasket cost about the same as the cork gasket because its relative volume was much less.

Then a change in the fluid to be sealed barred the use of any material containing cork. To meet the new service condition, Armstrong developed a special straight synthetic rubber compound. The joint was then redesigned (Figure 3) and the new compound tried in the form of molded rings. These rings sealed well, but their cost was high. Next an extruded piece was used with ends skived and cemented. This, too, provided an effective seal; but cost, while less, still was too high.

A final solution then was found by using a simple lathe-cut ring made of the same synthetic rubber material, square in cross section (Figure 3). Gasket cost, of course, was greatly reduced, yet a perfect seal was maintained.

There are many applications in which simplification of gasket shape can lead either to significant cost reduction or to improvement in safety and service factors. Thus the expense of molding or cutting intricate gaskets is avoided, as well as the extra cost of machining joints in special forms.

The possible use of a square-section gasket should be considered even where requirements inherent in the unit itself prescribe rounded or specially shaped joint surfaces, such as the rolled lip of a sheet metal case. Ordinarily a square or rectangular rubber or cork-and-rubber gasket will deform sufficiently under pressure to effect a tight seal.

We suggest that you discuss your sealing problems with an Armstrong representative while your designs still are in the development stage. Methods and materials that he may suggest may help to further simplify construction and reduce costs. In addition, he can supply samples for your experimental use. Call or write the Armstrong Industrial Division office nearest you.

If you prefer, send drawings and details to us for review. You'll find our recommendations unbiased and keyed to good current gasketing practice.

SEND FOR FREE BOOKLET. For specification and application data on Armstrong's more than 50 resilient sealing materials, send for a free copy of the latest edition of "Gaskets, Packings, and Seals," twelve pages of helpful information. Address Armstrong Cork Company, Gaskets and Packings Department, 5105 Arch St., Lancaster, Pa.

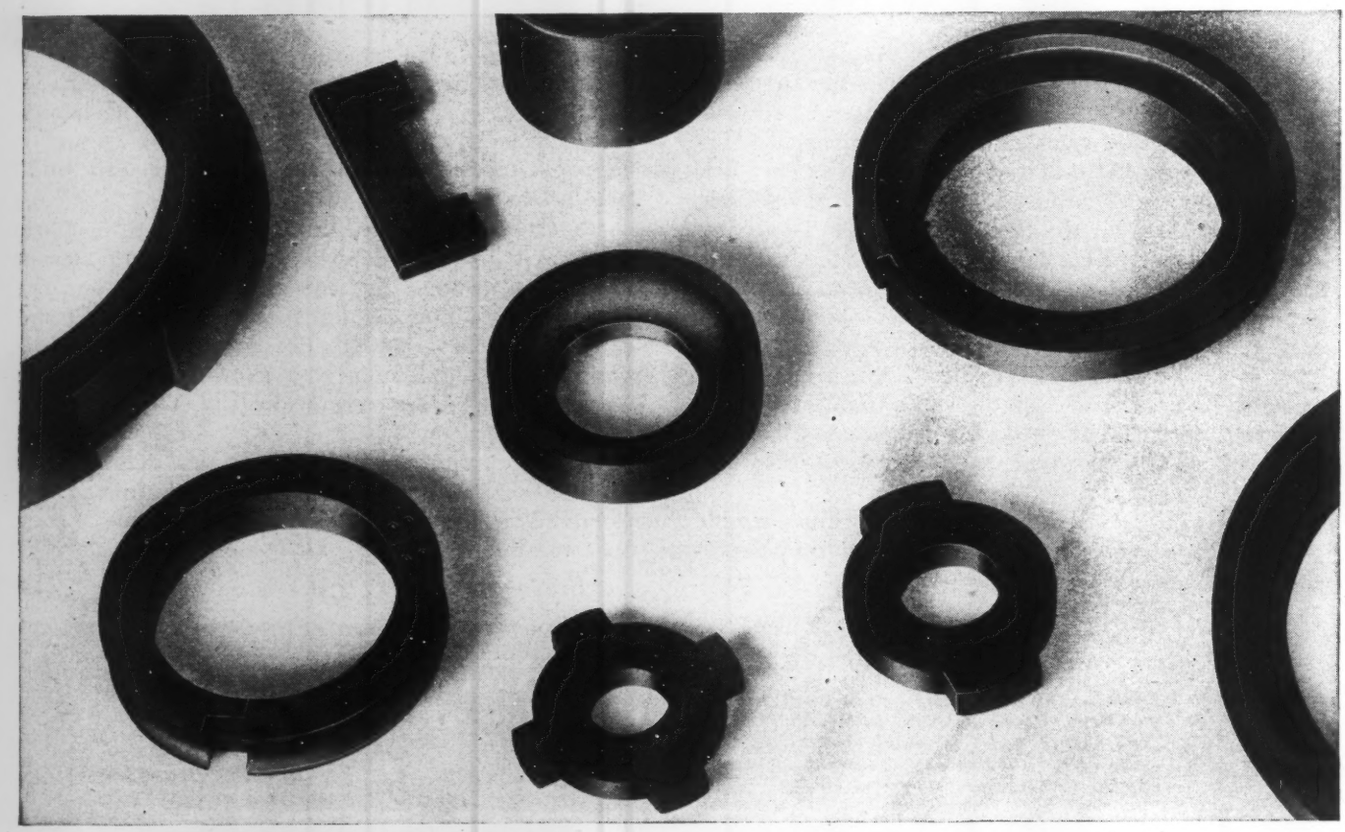
ARMSTRONG'S
GASKETS · SEALS · PACKINGS

Cork Compositions • Cork-and-Synthetic-Rubber Compositions
Synthetic Rubber Compounds • Cork-and-Rubber Compositions
Fiber Sheet Packings • Rag Felt Papers • Natural Cork

graphitar pistons, piston of GARDNER-

The use of Graphitar at vitally important points is one of the reasons for the high operating efficiency and dependability of the Gardner-Denver Company air compressor. Because the piston, piston rings, and piston rod are Graphitar, the compressor needs no lubrication at these points and hence delivers compressed air that is entirely free of oil. Springs seated in grooves machined in the piston expand the Graphitar segmental piston rings to compensate for slight wear, assuring permanent effective sealing. The Graphitar packing rings also are segmented and contract under spring pressure to provide dependable sealing throughout constant use.

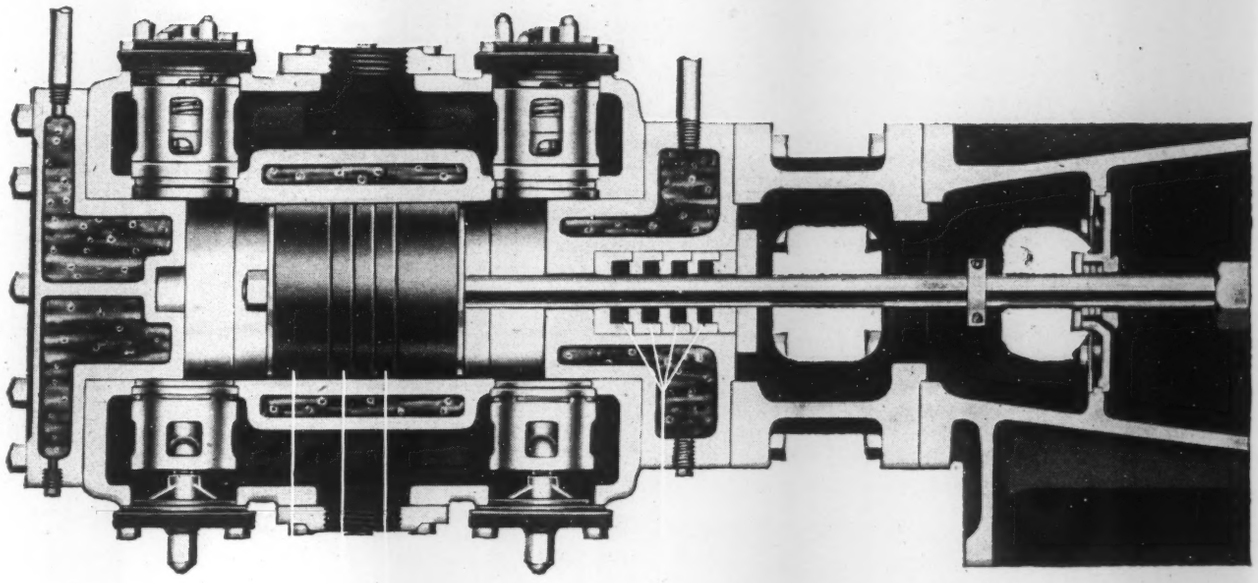
GRAPHITAR IS VERSATILE. Self-lubricating, light-weight, highly resistant to wear, temperature extremes and chemical attack, Graphitar is the ideal material for seals, rings, pistons, cylinder liners, and other parts in a wide variety of mechanisms. We are equipped to produce Graphitar parts in any practical size and shape. Tolerances may be as close as .0005" in small sizes. Send us sketches or descriptions of your products and our engineers will show you where Graphitar parts will improve mechanical performance and save you money. Write for 44 page catalog.

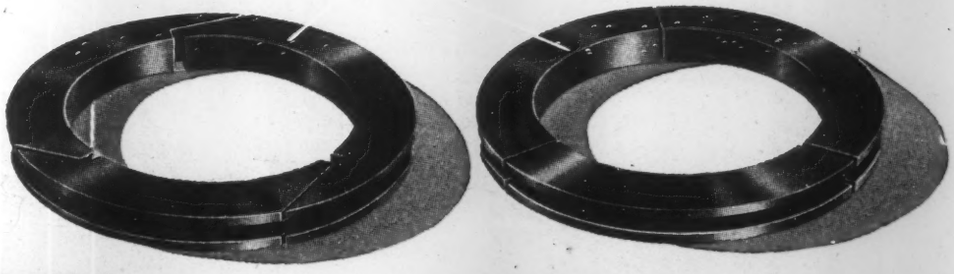


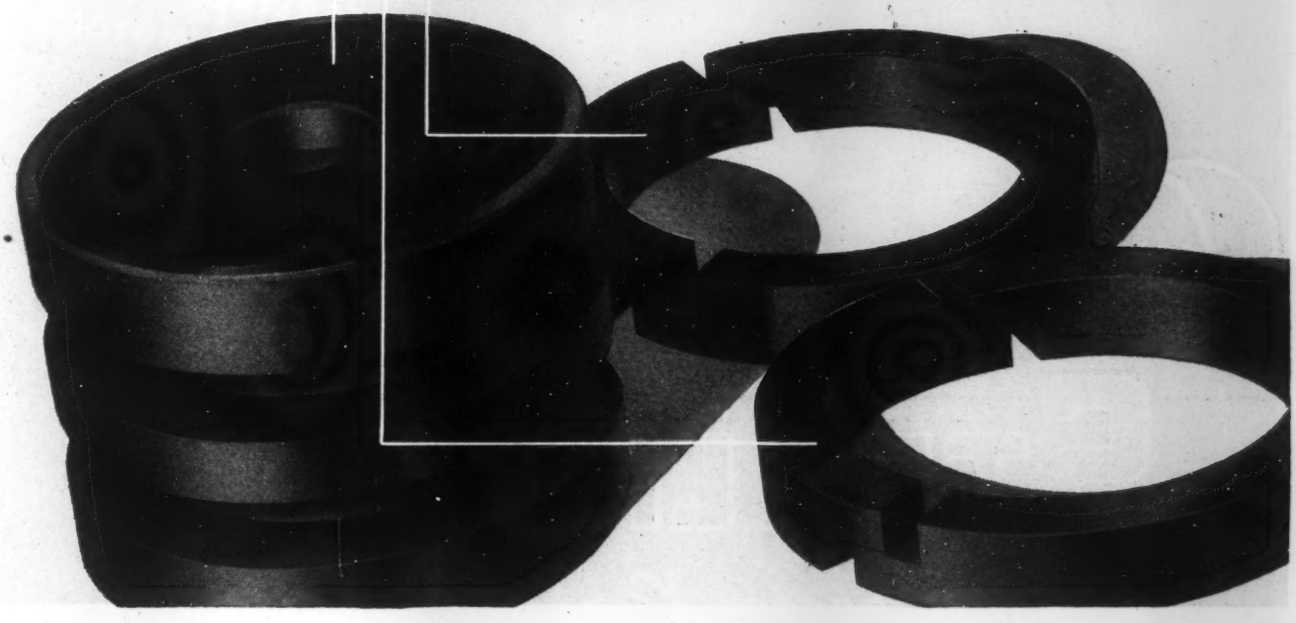
THE UNITED STATES GRAPHITE

rings and seals improve performance

DENVER air compressors

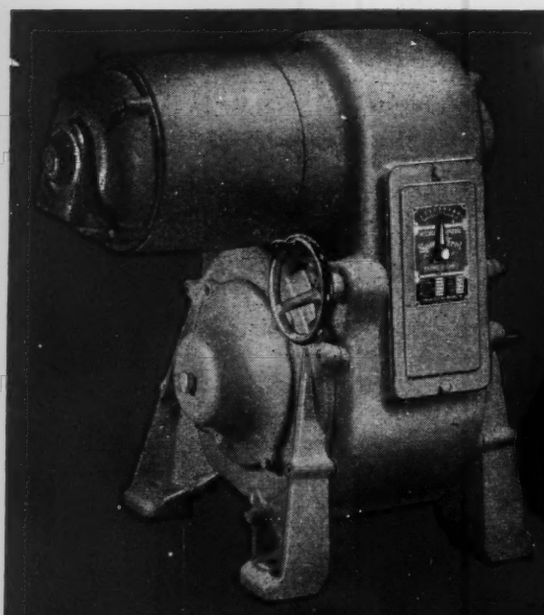






COMPANY • SAGINAW, MICHIGAN

Three Ways To Cut Production Costs –

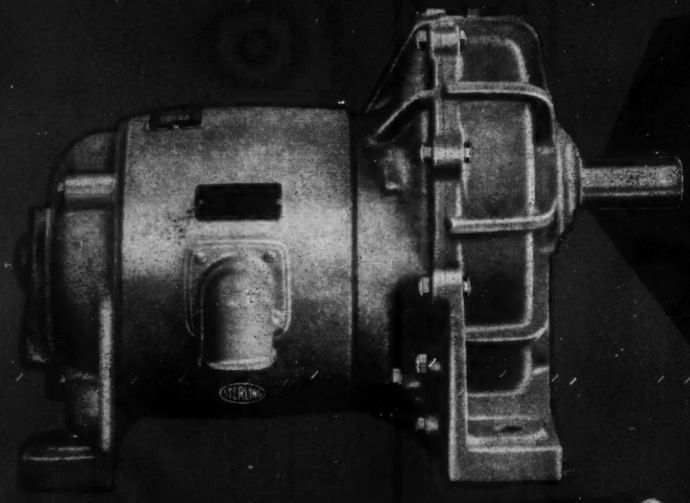


Variable Speed

Sterling Speed-Trol is a proven, self-contained, infinite variable speed power unit. With Speed-Trol you can get the exact speed for maximum production.

H.P.—From ½ to 15 Ratios—From 2:1 to 6:1

STERLING SPEED-TROL MOTOR

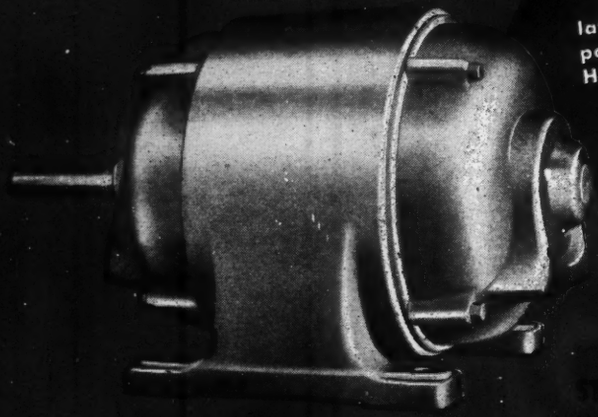


Slow Speed

Sterling Slo-Speed (Modern Gear System) Motors give you a complete power drive in one soundly engineered—compact—flexible—ultra efficient unit.

H.P.—From ½ to 15 Gear Ratios—From 3:1 to 50:1

STERLING SLO-SPEED MOTORS



Normal Speed

Sterling Standard Klosd Motors are the latest word in design, incorporating important improvements including patented Herringbone Rotors.

H.P.—From ½ to 15

STERLING Standard KLOSD MOTORS

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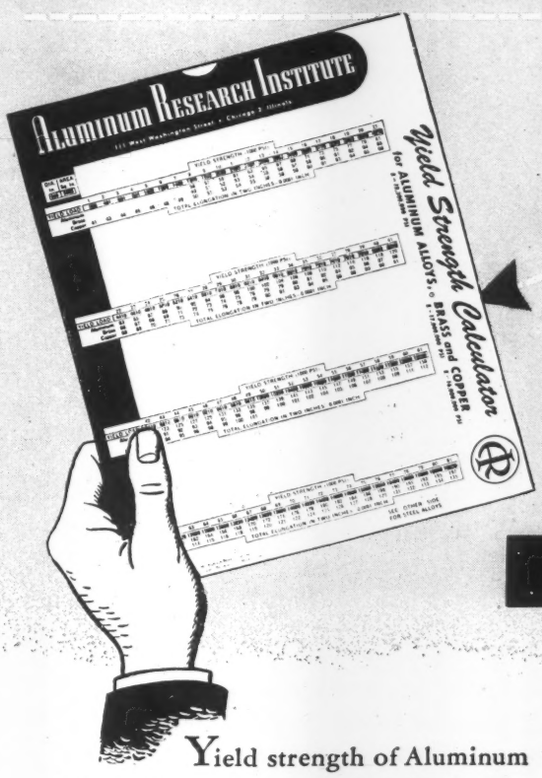
New Accurate RAPID METHOD

For YIELD STRENGTH Determination



- For Aluminum Alloys, Brass, Copper, Steel (carbon and low alloy)
- By Calculator — Without Stress-Strain Curves
- Results obtained in 3 minutes
- Method described in *ASTM Bulletin*, March, 1947

AN A.R.I. PROJECT FOR INDUSTRY

Yield strength of Aluminum Alloys, Brass, Copper and Steel (carbon and low alloy) can now be determined in a fraction of the time usually required.

The ARI YIELD STRENGTH CALCULATOR is new, convenient, accurate, economical, and as easy to use as a slide-rule. One skilled operator can run as many as 20 complete tests per hour.

Developed at the Case School of Applied Science as part of a continuing research program for Aluminum Research Institute, and described in a paper by Ebert, Fried, and Toole in the *ASTM Bulletin* for March, 1947, the ARI YIELD STRENGTH CALCULATOR is offered at approximate cost of production.

Printed in color on heavy varnished stock, size 8″ x 10″, it is mailed in convenient filing envelope.

ARI Yield Strength Calculators are available from Aluminum Research Institute at $1.00 each, postpaid

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WE MIND *your* P's AND Q's

Powder Parts of Quality—in Quantity

The never-ending quest for product improvement is bringing about a constantly widening acceptance of metal powder parts. Designers and builders have learned that parts suited to production by powder metallurgy can be turned out more uniformly and more rapidly than by conventional methods. Yet, in many applications, the metal powder part is less costly to use. It requires fewer or none of the secondary machining operations necessary with a casting or a forging.

Moraine is producing metal powder parts in greater and greater variety as their qualities and economies gain recognition in more and more fields. Single orders usually run to many thousands of units, for it is only in quantity production that the cost savings are considerable.

If you have need for identical parts, fabricated to close commercial tolerances, finely finished, and in sizable quantities, let our engineers determine whether powder metallurgy can do a job for you.

MORAINE PRODUCTS DIVISION OF **GENERAL MOTORS**

DAYTON, OHIO

We Like Tough Jobs!

TAKE A LOOK AT THE McDONNELL PHANTOM

FOR INSTANCE

HERE'S the fastest thing with wings that ever took off from an aircraft carrier's flight deck—the McDonnell Phantom!

Powered by two turbo-jet engines—streamlined to achieve a top flight speed of over 500 miles per hour—it still has the stability and control characteristics at slow landing speeds comparable to conventional carrier-based planes.

This is another major development in modern aircraft in which Foote Bros. "A-Q" Gears and Power Units are playing a part.

On the axial flow turbo-jet engines the accessory drive units are produced by Foote Bros. In the wings of the Phantom, Foote Bros. actuators supply immediate response in raising and lowering speed brakes—so important in the control of this swift plane.

Manufacturers of many types of industrial equipment requiring gears of extreme precision are finding in Foote Bros. "A-Q" (aircraft quality) Gears an answer to problems of greater efficiency, higher speed, unusual compactness, light weight and low noise level.

Manufacturers of equipment requiring absolute control of operations from a remote point may find an answer in Foote Bros. Power Units and Actuators. These units are individually engineered to the job they are intended to do, and assure compactness, light weight, and, above all, positive control of linear or rotary motion within an exact time cycle. They also provide the extremely accurate mounting of "A-Q" Gears—so essential if the full benefit of their precision is to be realized.

Of course, you as well as thousands of other leading manufacturers will continue to look to Foote Bros. for industrial gears of all sizes and types and speed reducers in a wide range of ratios as you have since 1859.

Two engineering bulletins, one on "A-Q" gears, the other on Power Units, offer many suggestions on new developments in application of power. If you have not received copies, mail the coupon below.

FOOTE BROS.

Better Power Transmission Through Better Gears

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with ACADIA Synthetic Rubber

SHEETS • EXTRUSIONS
CUT AND MOLDED PARTS

Component parts processed from Acadia Synthetics excel in many characteristics—including plasticity, elasticity, resilience, etc.—plus greater resistance to light, air, heat, wear, oil and age. Possible applications are almost unlimited. Acadia Synthetic Rubbers cut, mold and extrude to very close tolerances—in any shape, size or type.

In checking specifications, you may find that the original part, re-designed in an Acadia Synthetic, gives superior performance, greater dependability and longer service—*very often at lower cost.* Whatever your requirements may be . . . Acadia's engineers will gladly help you select the right synthetic rubber and adapt it to your product. *Write today.*

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ACADIA *Synthetic* **PRODUCTS**

Processors of Synthetic Rubber and Plastics • Sheets • Extrusions Molded Parts

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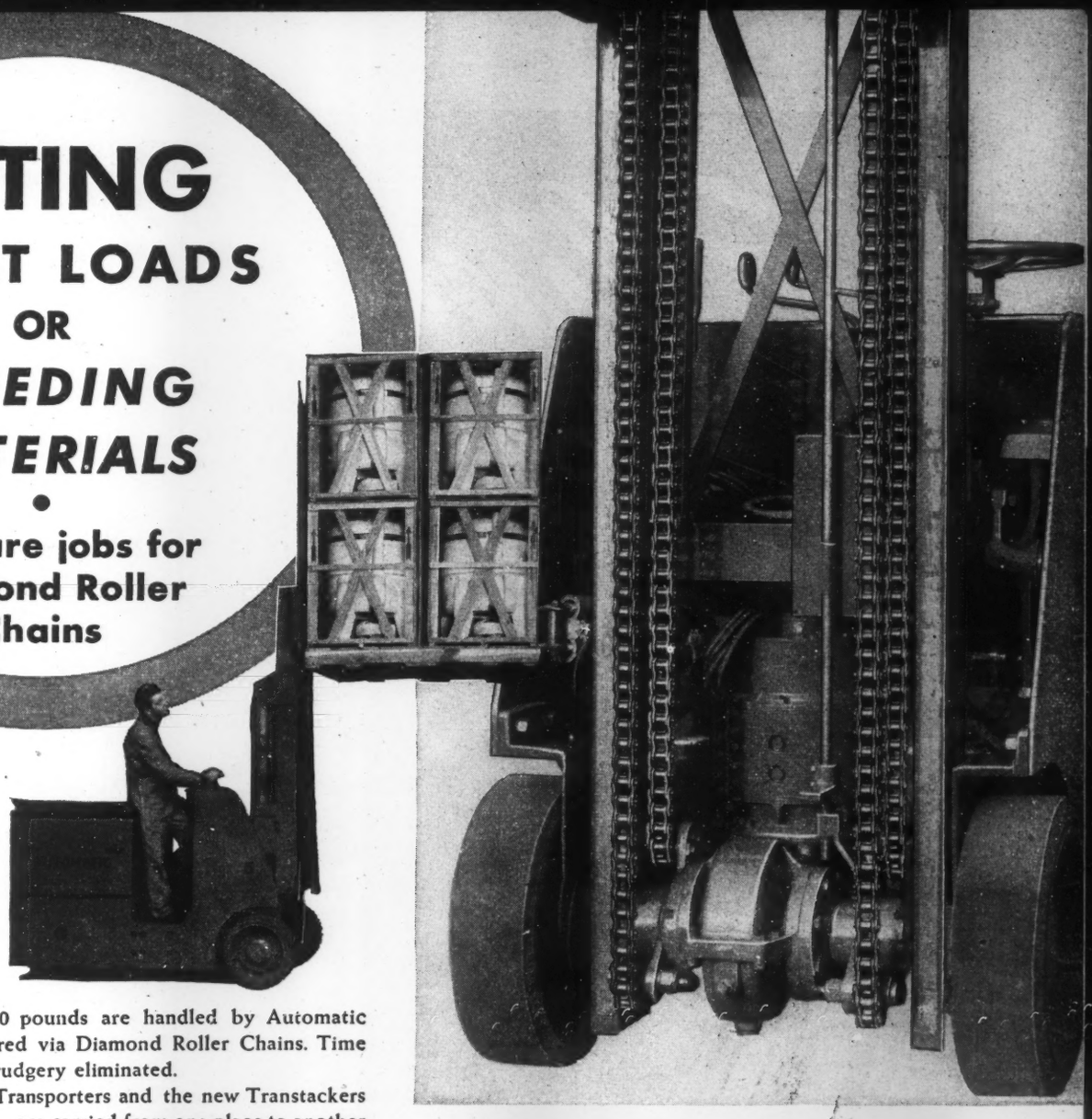
LIFTING GREAT LOADS OR *SPEEDING MATERIALS*

both are jobs for Diamond Roller Chains



Close-up view shows the high strength Diamond Roller Chains that raise and lower the loads carried on the elevating carriage of the Automatic Tilting and Tiering Fork Truck. Transporting, raising and tiering of materials is a simple one-man job.

Loads as high as 60,000 pounds are handled by Automatic Fork Trucks—raised and lowered via Diamond Roller Chains. Time and space are saved—human drudgery eliminated.

Loads carried on Automatic Transporters and the new Transtackers are carried from one place to another without manual pulling and hauling with Diamond Roller Chain Drives delivering the power from motor to drive wheel.

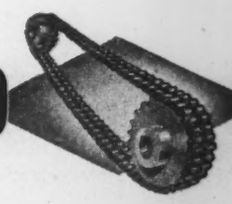
For many years, Automatic Transportation Company have employed Diamond Chains on a long line of materials handling equipment—roller chains of great strength and reliability for elevating duty, and high-speed double-strand chains for the motor drives.

AUTOMATIC Transporter for pallet and platform requires only guiding. Motor delivers power to drive wheel through Diamond Drives shown above.

The position of preference attained by Diamond Chains is a result of over 50 years' specialization in the manufacture of roller chains, with the continuous development and improvement such specialization brings about. Long experience, new alloy steels, augmented heat-treating methods, especially designed fabricating machinery, wide diversity of application—all have had a part in the final high uniform quality of the *one* product made—Roller Chain.

Engineers, machinery designers and manufacturers of greatest experience assure maximum performance with DIAMOND Roller Chains. Machinery buyers recognize them as an indication of sound engineering.

Whatever your drive problems—in small or large capacities, for high or low speeds, Diamond engineers can help save your time with practical recommendations. Chain & Sprocket Catalog No. 595 is yours for the asking. DIAMOND CHAIN COMPANY, Inc., Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana. Offices and Distributors in All Principal Cities.

DIAMOND  **ROLLER CHAINS**

Eliminate

Leakage, Gland Adjustment and Shaft Wear from Rotary Equipment

Synthetic Rubber Bellows—tail seals on shaft. Head is flexible; automatically compensates for washer wear, shaft vibration, and play. Gland adjustment is eliminated.

Protecting Ferrule—assures free movement of bellows at all times.

Sealing Washer—rotates with shaft and is driven through metal parts. No torque on bellows. Washer made of anti-frictional material—cuts power loss to a minimum.

Floating Seat—cushioned by synthetic rubber sealing ring, eliminating stress distortion of sealing faces.

Sealing Faces—both carefully lapped to insure a perfect seal. Sliding seal contact is made at this point only; there is absolutely no wear of the shaft.

Specify JOHN CRANE SHAFT SEALS

The JOHN CRANE Shaft Seal is being applied with tremendous success to all types of equipment involving rotating shafts. Service and product-improvement records have been outstanding, for this self-adjusting seal practically eliminates the human element in maintenance.

Investigate the JOHN CRANE Shaft Seal. Let our Engineers show you without obligation how this seal can add new sales features to your products.

Write today for illustrated Shaft Seal Bulletin.

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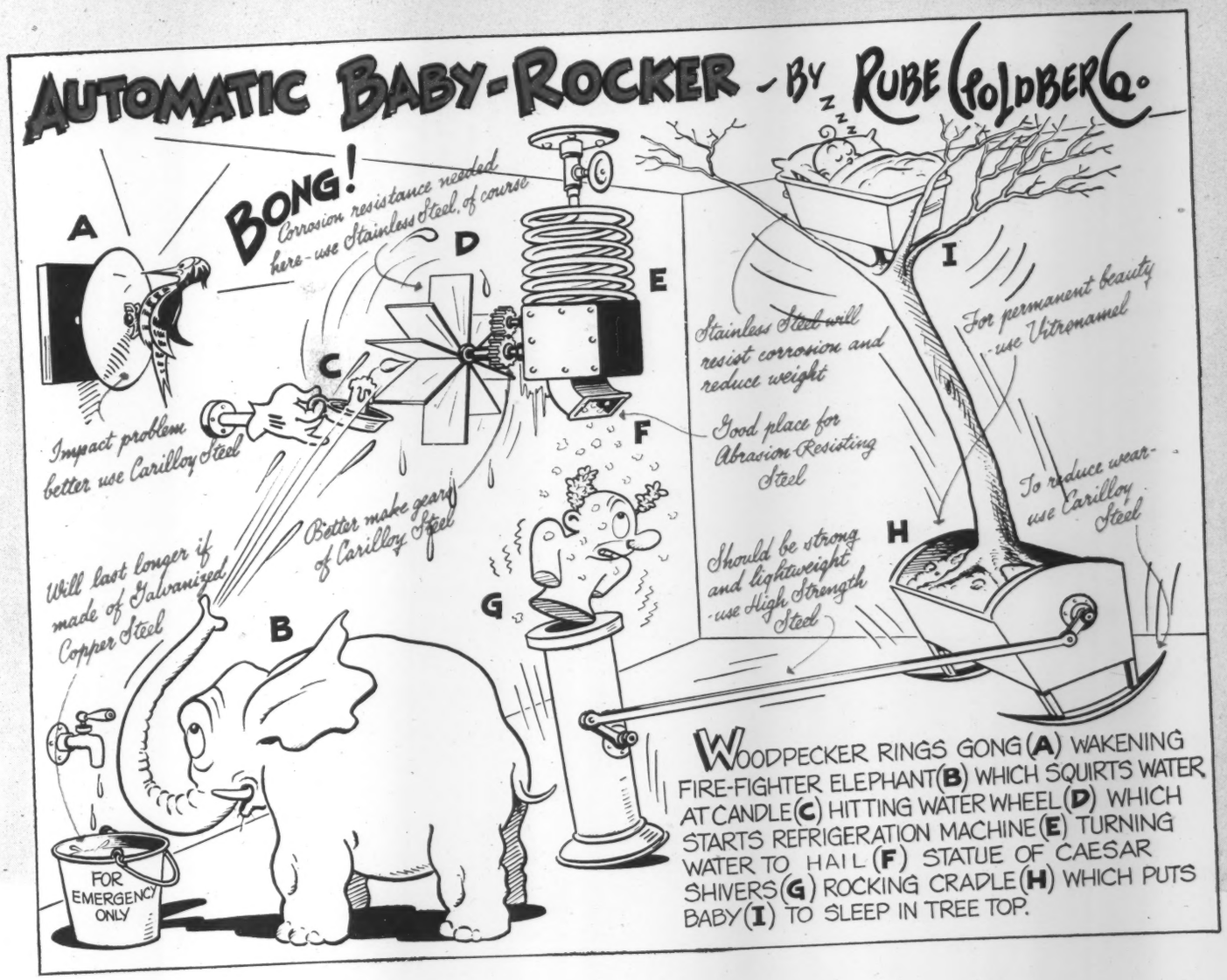

● While Mr. Goldberg's technique of baby-rocking may not be the most widely-accepted one, it does point out an important fact—only steel can do so many jobs so well.

When you want your product to have exceptional strength combined with light weight . . . when your product needs resistance to impact, shock, wear and corrosion . . . when ability to withstand extremes of heat or cold is essential . . . 9 times out of 10 steel will do the job best.

Steel is available in many different forms with widely different properties. It can be used in many different ways for widely different purposes. Steel, more than any other material, can meet every fabricating demand. That's why steel is generally the "first choice" material with designers, manufacturers, and builders.

Our representatives will be glad to discuss with you the type or grade of steel that is best suited to meet your requirements.

CARNEGIE-ILLINOIS STEEL CORPORATION
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Have you explored the possibilities of these special purpose U·S·S Steels?

U·S·S STAINLESS AND HEAT-RESISTING STEELS to assure high resistance to corrosion and heat, and to reduce weight.
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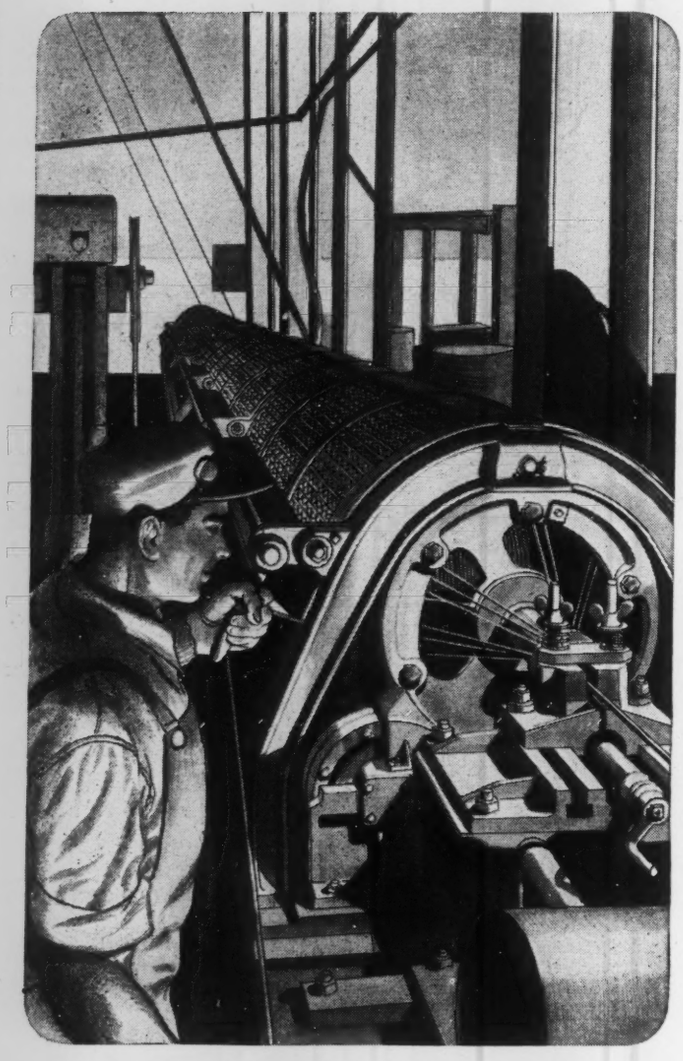
U·S·S COPPER STEEL to give at least twice the atmospheric corrosion resistance of regular steel at little additional cost.
U·S·S ABRASION-RESISTING STEEL to combat wear and friction.
U·S·S HOT-ROLLED AND COLD-ROLLED STEELS to provide the basic advantages of steel, plus maximum economy in each job.
U·S·S PAINTBOND—A galvanized, Bonderized sheet that permits immediate painting and holds paint tighter.
U·S·S VITRENAMEL—Sheets designed especially for porcelain enameling.
U·S·S ELECTRICAL SHEETS for motors, generators and transformers.

USS STEEL
UNITED STATES STEEL

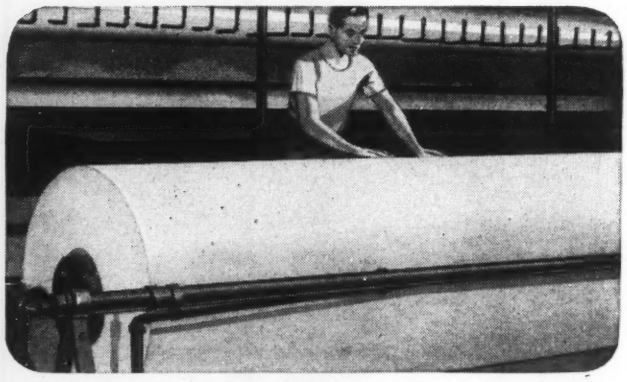
9 times out of 10 STEEL will do it better

UNITED STATES STEEL

Watch industry Fluid-Drive* ahead!



1 Cable Manufacturing. Looking for savings? Standard, constant speed AC motors gain new flexibility when equipped with Gýrol Fluid Drive. A vortex of oil takes up the load smoothly—pulls evenly from dead stop to full speed —protects equipment against overloads.



2 Paper. Gýrol Fluid Drive has helped paper manufacturers to simplify equipment and to cut maintenance costs. In this industry Fluid Drive is used to transmit power to slitters, coaters, draft fans, rewinders and conveyors.

3 Plastics. You get adjustable speed control at its best with Gýrol Fluid Drive on extruders, pumps, fans, rotary driers, agitators, crushers and compressors. Here's faster, easier selection of the most efficient speed for a given process.

4 And You? We firmly believe that industry has only started to explore the uses for Gýrol Fluid Drive. *Quite possibly you can find profitable new uses in your plant, processes or product.* Why not investigate the matter with our engineers?

AMERICAN BLOWER

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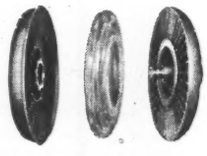
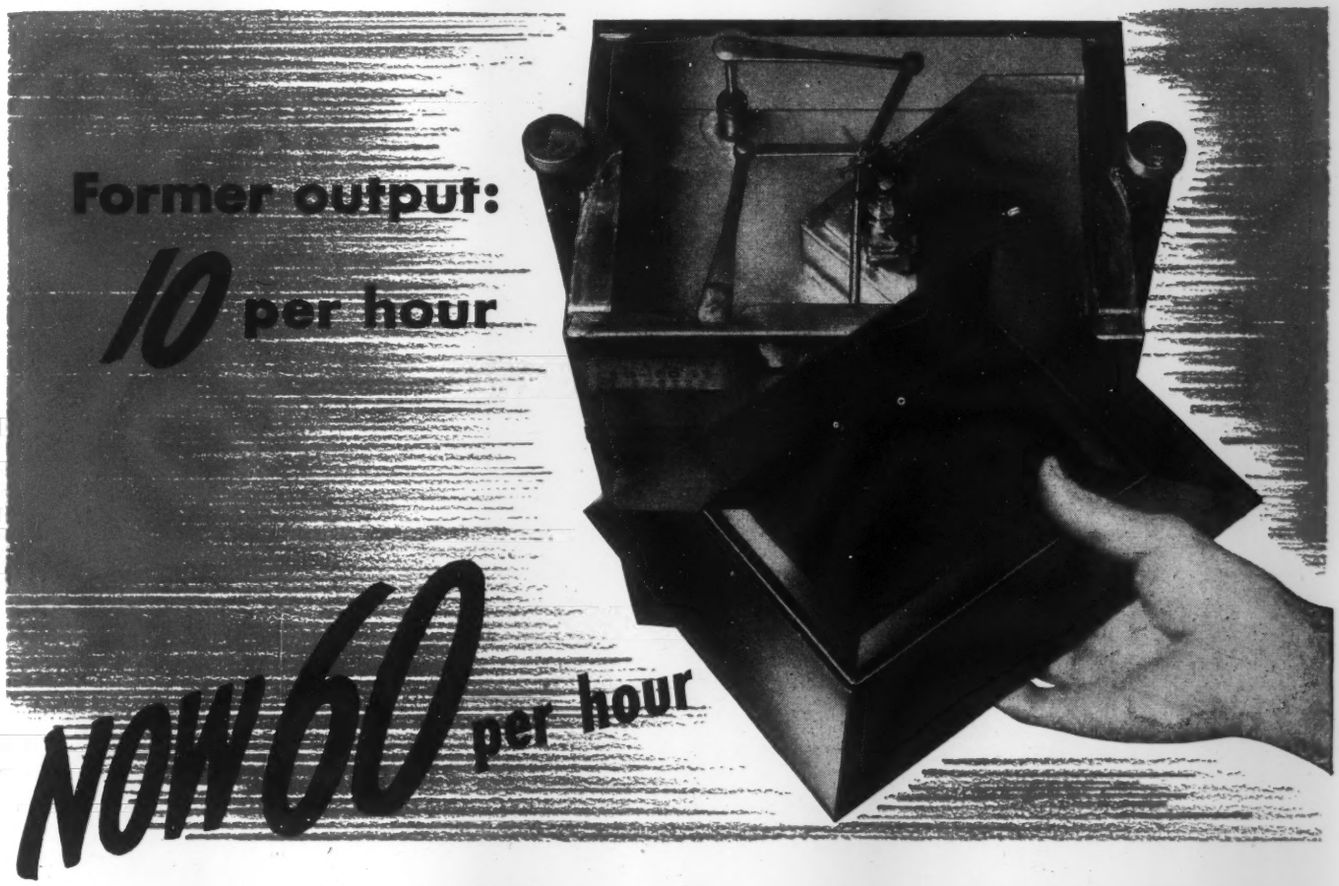
In Canada: CANADIAN SIROCCO CO., LTD., Windsor, Ont.

Division of American Radiator & Standard Sanitary corporation

GET GÝROL *Fluid Drive*



* **Gýrol Fluid Drive** *is a fluid power transmission pioneered and developed for American industry by American Blower. It is used wherever smooth transmission of power or adjustable speed control is desired. Looking beyond the long list of applications already developed, we will gladly work with you to find new ways to "Fluid-Drive Ahead!"*



with TOCCO Induction Heating

IN the de-soldering of gas meter panels a large mid-western gas company reports the following improvements with TOCCO Induction Heating:

With former hand method, it was possible to clean and de-solder about 10 tops per hour ("5-light" size meter). Top panels are 7" x 9½".

Now 6 times as fast. With a TOCCO 7½ KW Machine, one man de-solders about 60 panels per hour. Cleaning is eliminated. He simply places the meter in a fixture and presses TOCCO button. Solder melts in about 16 seconds and panel drops off. Floor-to-floor speed is about 60 seconds. Output is 60 per hour . . . 600% as fast as former method. Working conditions are better because heating is localized in work.

The TOCCO Engineer will gladly analyze your soldering, brazing or heat treating problems for similar improvements.

THE OHIO CRANKSHAFT COMPANY

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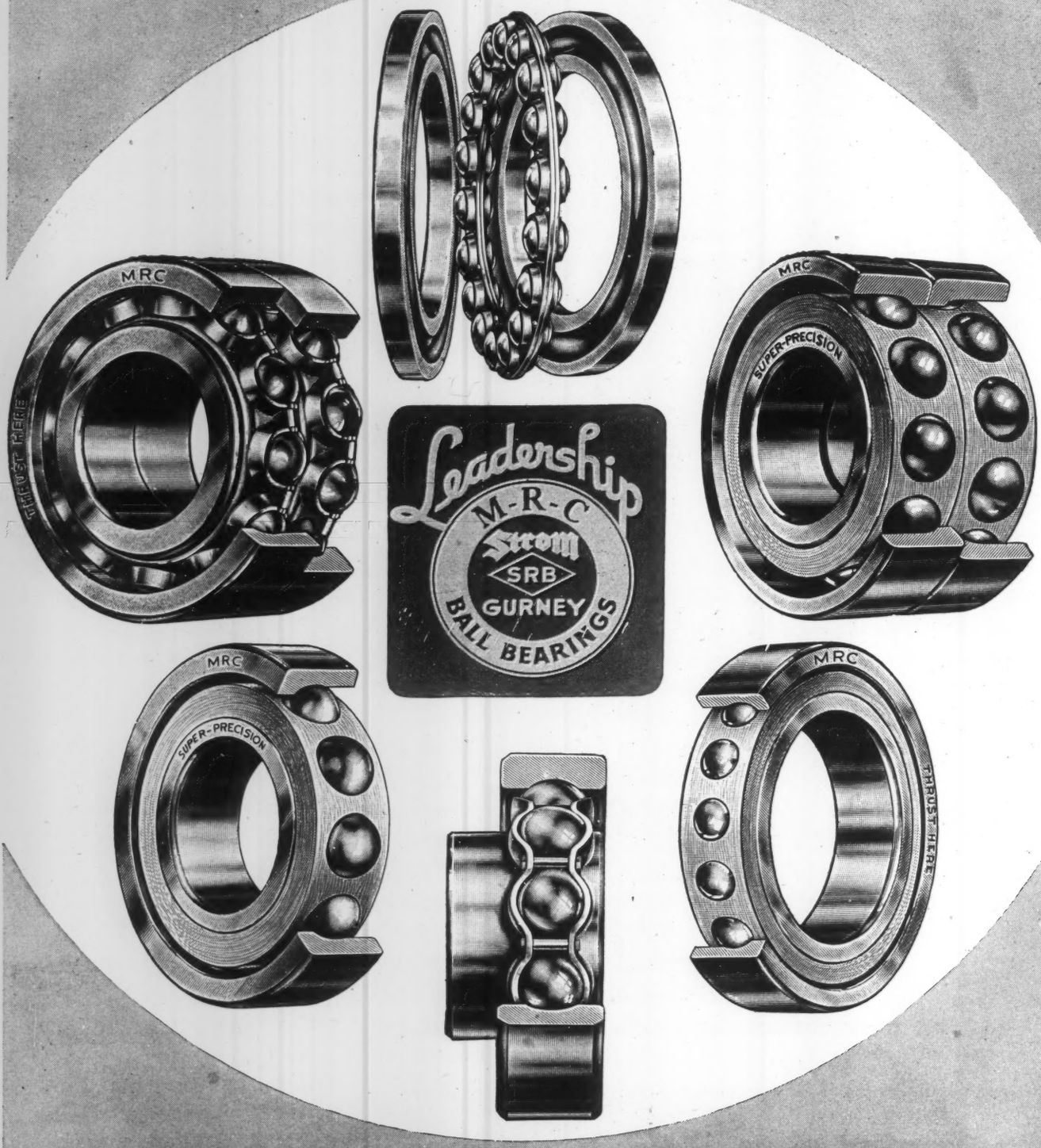
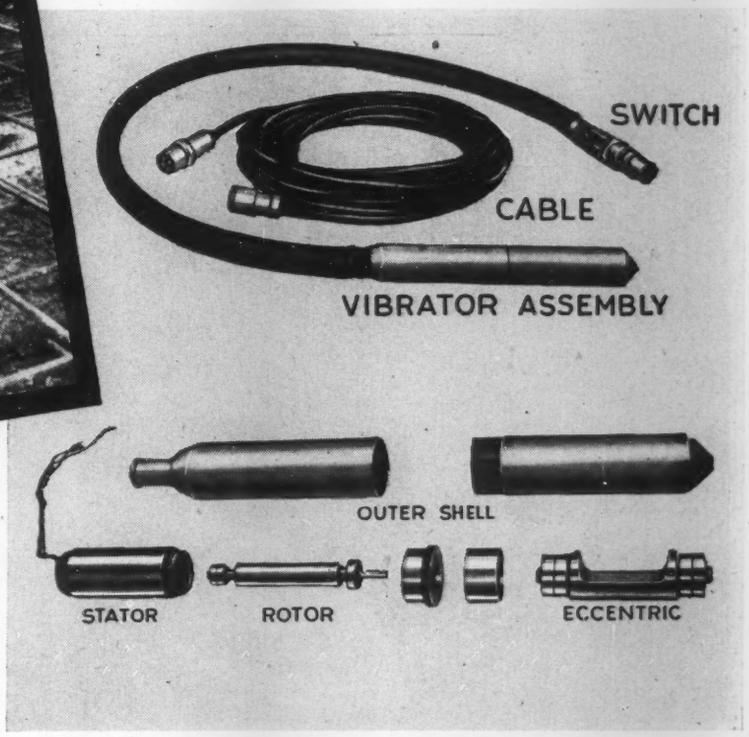
M-R-C BALL BEARINGS



MARLIN-ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, N. Y.

PUTTING THE MOTOR ON THE JOB



R & M MOTOR PARTS MAKE THIS VIBRATOR *REALLY PORTABLE*

Robbins & Myers Matched Motor Parts open a wide field for *compact, built-in* electric power applications. Not only do they permit modern, streamlined designing, but they meet many needs to which conventional assemblies cannot be adapted. Among this latter group is a new motor-driven vibrator for settling freshly poured concrete—an easily handled, easily controlled unit which far surpasses all previous models in actual portability and working range.

CONCENTRATED POWER

The built-in R & M motor parts used in the Maginniss Electric Concrete Vibrator, made by the Maginniss Power Tool Company of Mansfield, Ohio, are a *triumph* of engineering skill. Operating on 180-cycle current, the motor turns an eccentric weight at a speed of 10,000 r.p.m. Field tests show the motor capable of pulling a 1¼ h.p. load without excessive heating.

The motor assembly, together with the eccentric weight, is fitted into a case-hardened steel tube only 2⅜″ outside diameter to form the vibrator head.

INGENUITY AT ITS BEST

Motor parts are correspondingly small, the solid copper bar rotor being just 1″ diameter, while the iron stack is 4″ long with an outside diameter of 2⅛″. The winding is glass insulated. Heat is removed by convection through the steel shell into the concrete medium, which under vibration acts as a fluid. The only parts of the machine subject to wear are the ball bearings. There are no brushes or commutator.

HUNDREDS OF SIMILAR APPLICATIONS

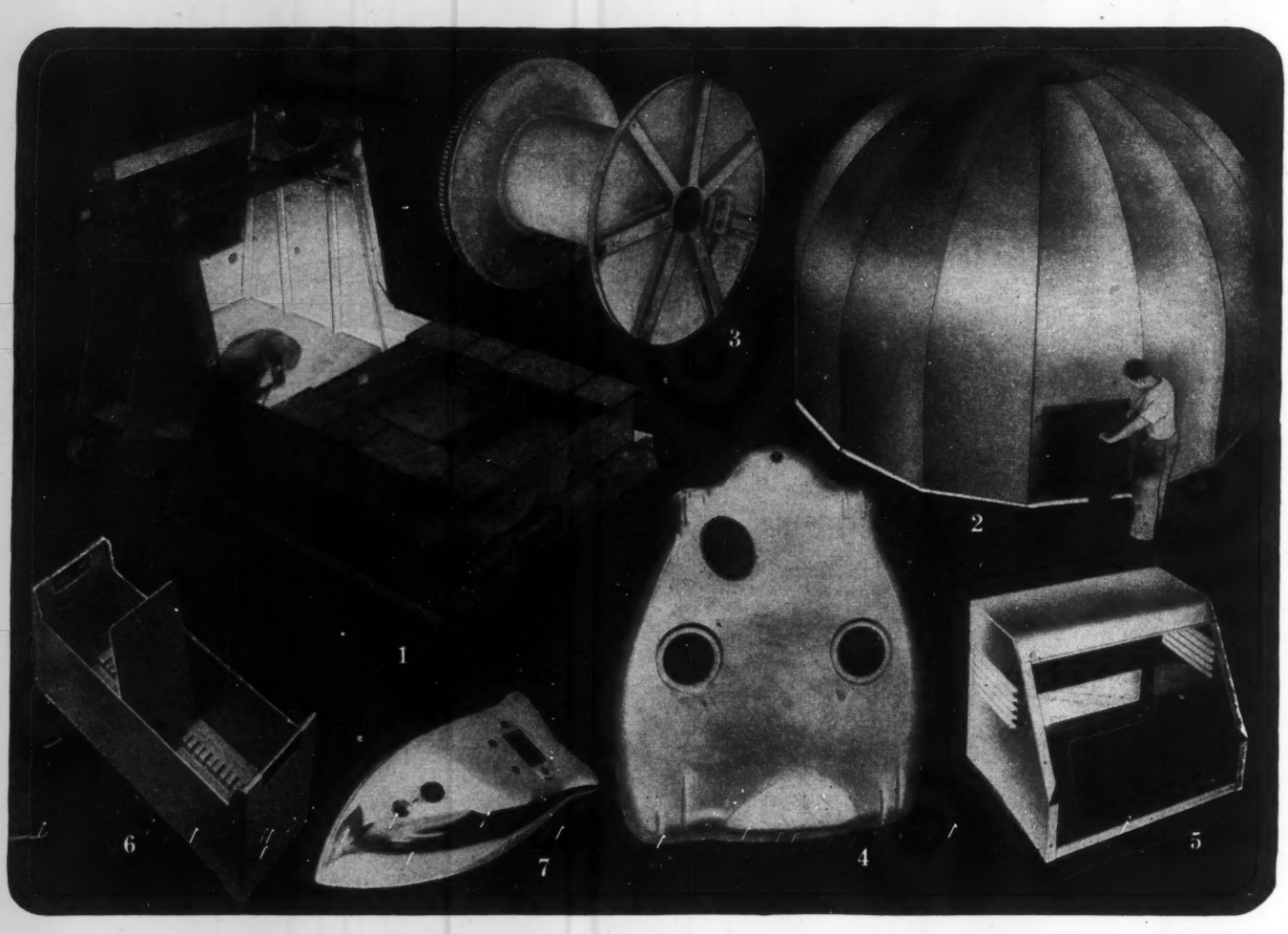
Manufacturers everywhere have found Robbins & Myers Matched Motor Parts the *key to functional design and production simplification.* They are already built into hundreds of different power tools, appliances, and small machines. Make use of this R & M engineering experience in developing your products.

Write today for informative booklet, "Matched Motor Parts."

ROBBINS & MYERS • INC. MOTOR DIVISION • SPRINGFIELD, OHIO
In Canada: Robbins & Myers Co., of Canada, Ltd., Brantford, Ont.

MOTORS • HOISTS • CRANES • MACHINE DRIVES • FANS • MOYNO PUMPS • FOUNDED 1878

7 UNUSUAL METAL WORKING JOBS

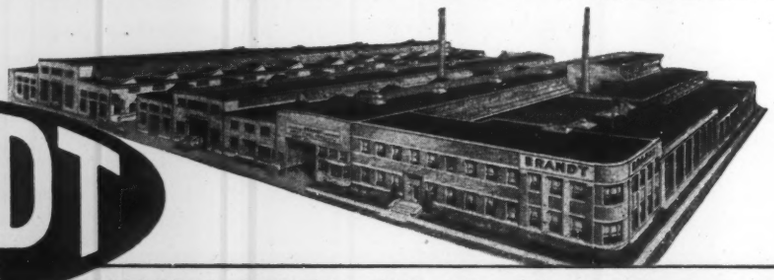


Specialized Work—ranging from 14,000 lbs. to a few ounces—for exacting customers

Brandt's ability to solve out-of-the-ordinary metal working problems in an extreme range of sizes and metals is illustrated by the 7 products shown above. The aluminum electric iron stampings were mass-produced to close specifications on a rush order. In contrast, the 14,000 pound precision Weldments (1), were tailor made to exacting Naval specifications. The Protective Housings for Naval Guns (2) are huge 15 ft. diameter units of 16 gauge steel, produced on assembly line basis, and made in their entirety by Brandt.

The other products shown were made for Specialized Aircraft, Electronic, Marine and Office equipment. Widely different in size, metals, specifications and quantity, the production of each of these orders demanded Specialized Facilities.

1. 14000 lb. Steel Weldments
2. Protective Naval Gun Housings
3. Intricate Steel Weldments
4. Aluminum Aircraft Fuel Tanks
5. Steel Radio Jackets
6. Steel Office Files
7. Aluminum Iron Housings



*ALL UNDER ONE ROOF

BRANDT
BALTIMORE

CHARLES T. BRANDT, INC., 1700 RIDGELY ST., BALTIMORE-30, MD.

Precision METAL CRAFTSMEN SINCE 1890 ★ ★ ★ ★

$250,000 more output with Farval

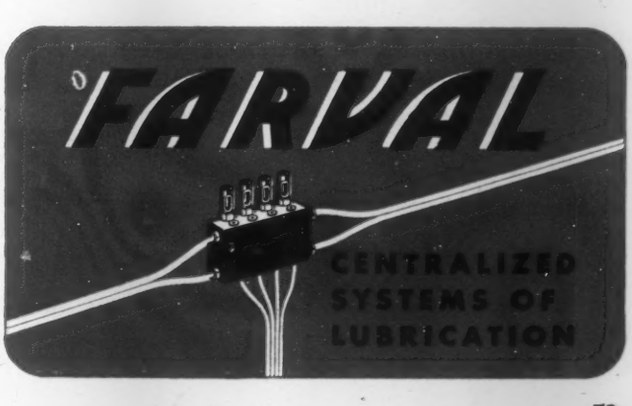
FARVAL—*Studies in Centralized Lubrication No. 88*

IN the tire and tube department of a rubber company, it was necessary to shut down the vulcanizers to lubricate them by hand. A study by the Methods Department showed that the production lost during this shutdown time was equivalent to the full output every day of five vulcanizers. Measured in tires and tubes not produced, the indicated annual loss was well over 50,000 units. Additional vulcanizers to make up this loss would have cost more than $45,000.

The company turned to Farval Centralized Lubrication, for with Farval it is not necessary to stop machines to lubricate them. By eliminating the need for additional vulcanizers and through savings in labor and lubricant, the Farval installation would pay for itself in less than 10 months. And the value of the tires and tubes to be produced in the time saved is well above a quarter million dollars.

Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, while a machine is in operation. Farval is the Dualine System with the Positive Piston Displacement Valve. This valve has but two moving parts and is fully adjustable, with a Tell-tale indicator at each bearing to show the job is done. For a full description of Farval, write for Bulletin 25. The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



Less "dead" metal . . . More "live" profits!

. . . with PERMITE Permanent Mold ALUMINUM ALLOY CASTINGS

There's less "dead" metal to remove when aluminum alloy castings are made by the Permite permanent mold process. Precision tolerances as close as ±.010" provide consistent uniformity in duplication of design and freedom from dimensional variations.

As a result, machining operations are speeded up. You save time, labor and money . . . get faster, lower-cost production, higher profits.

Other profitable savings are possible, too, thru the greater tensile strength of Permite Permanent Mold Castings, which often permits thinner cross-sections and a resulting reduction in the weight and cost of your castings.

Permite Engineers and Foundrymen place at your service their twenty-seven years of experience in working with aluminum alloys. Let them show you how Permite Permanent Mold Castings can save you money. Submit your blueprints and specifications, without obligation.

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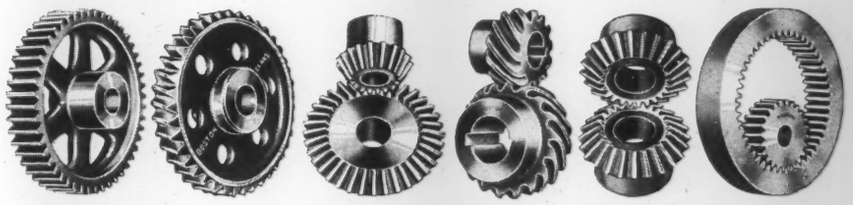
ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS...HARDENED, GROUND and FORGED STEEL PARTS

How shall I rig up that drive?

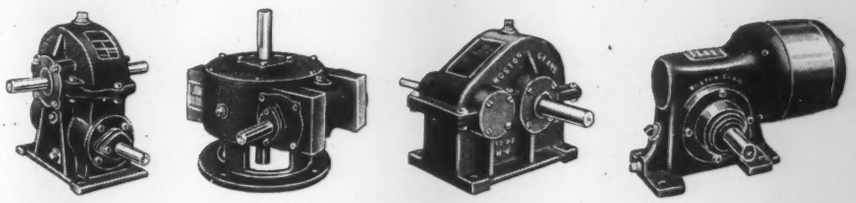
USING GEARS

Your drive may require any one of these types of gears — spur gears, worms and worm gears, bevels, helicals, miters, internal gears — or a combination of these types. For easier selection of your requirements the Boston Catalog lists many stock sizes from ¼" diameter up to 40" diameter.



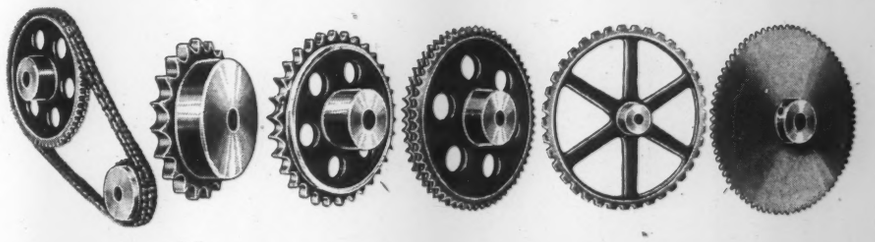
SPEED REDUCERS

Made-to-order gear housings and lubricating problems are eliminated when you select a modern speed reducer — a completely engineered and inclosed gear box ready for installation. The Boston Catalog lists 20 different speed reducer types and also gives you valuable data to use in the selection of the right unit for your drive.



SPROCKETS & CHAIN

For more flexibility in a positive drive, sprockets and chain may be your answer. Long center distances are a primary feature. Stock sprockets are listed in the Boston Catalog if your drive is from "flea" power up to 40 horsepower. For your information complete specifications and selection data are given in the Boston Catalog.



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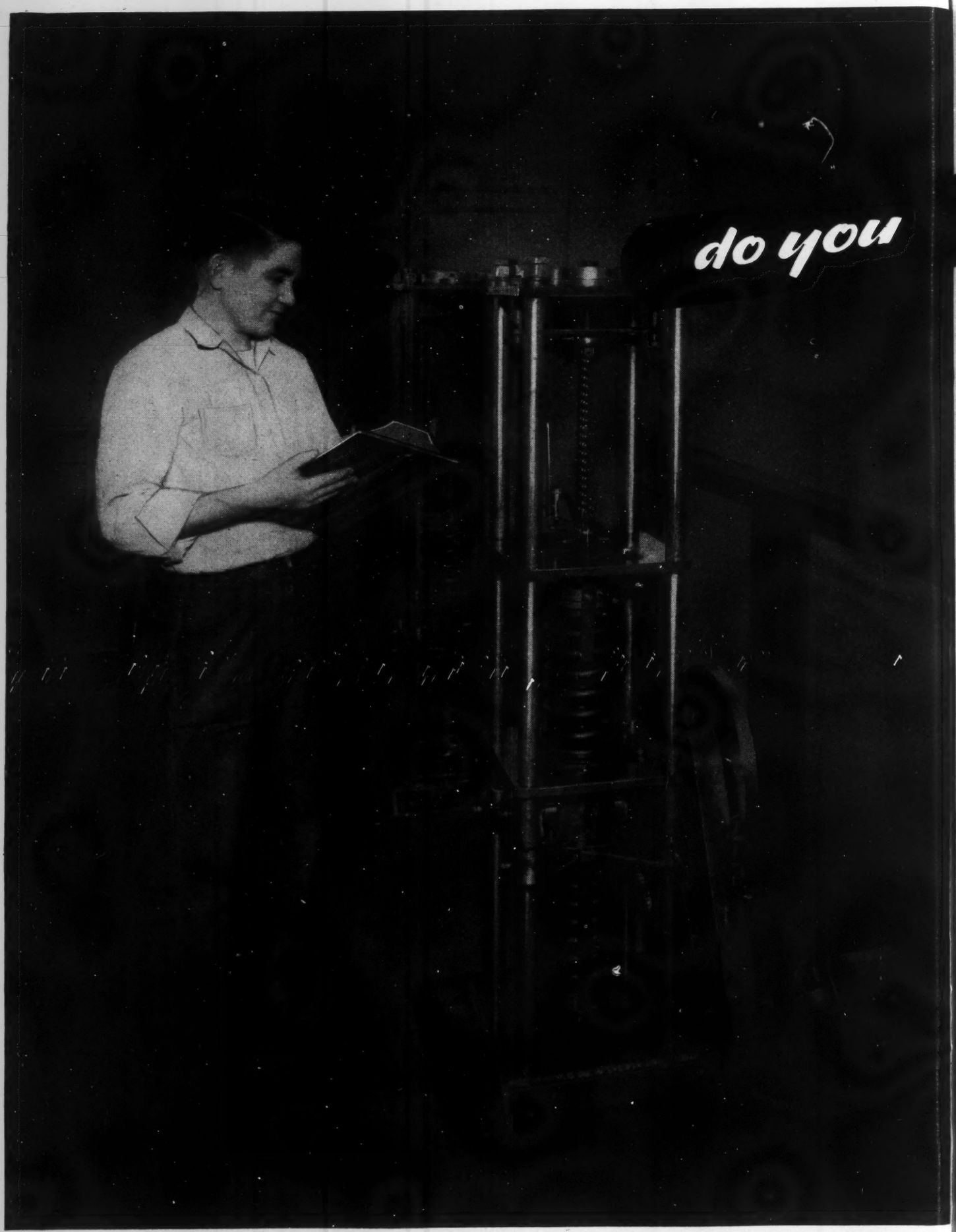
do you

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IS ACTUALLY ELASTIC?

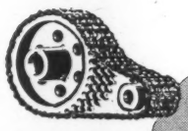
AND HERE'S WHAT THAT MEANS TO YOU. Where equipment is subject to momentary overloads and sudden strains, the inherent elasticity of roller chain helps to absorb those shocks, protecting your equipment from damage and excessive wear.

We've actually proved that roller chain is elastic. With this testing machine, designed and built by our engineers, we stretch a small section of Baldwin-Rex Roller Chain about ⅛ inch with each load application. We do this 10,000,000 times. Each time the chain must withstand the load and retract to its original length in order to meet our rigid specifications.

Besides proving our point on elasticity, this test gives us valuable data on performance...on metal fatigue...and chain design that enable us to build the extra quality into Baldwin-Rex. It's this combination of quality, elasticity and positive action that makes Baldwin-Rex roller chain the most efficient drive for your machines.

* * *

When specifying roller chain for your machines, remember that you can simplify chain selection, generally cut costs and improve deliveries by specifying standard roller chains. Your Baldwin-Rex man will be glad to give you all the facts and help you with your application problems. Call him or write direct to Baldwin-Duckworth Division of Chain Belt Company.



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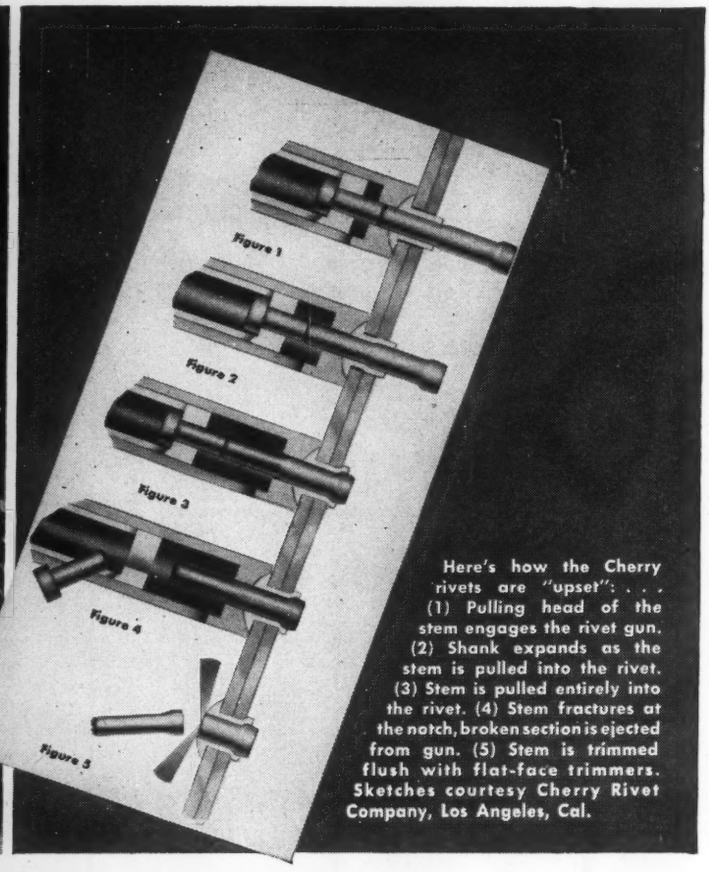
ROLLER CHAINS

BALDWIN-DUCKWORTH DIVISION OF CHAIN BELT COMPANY

320 Plainfield Street, Springfield 2, Massachusetts

Fastening an exterior plate on a motor coach with sturdy, corrosion-resistant Cherry blind rivets made of Monel.



Here's how the Cherry rivets are "upset": . . . (1) Pulling head of the stem engages the rivet gun. (2) Shank expands as the stem is pulled into the rivet. (3) Stem is pulled entirely into the rivet. (4) Stem fractures at the notch, broken section is ejected from gun. (5) Stem is trimmed flush with flat-face trimmers. Sketches courtesy Cherry Rivet Company, Los Angeles, Cal.

They *NAILED* a rivet problem

● Give us more of those Cherry one-man rivets, automotive engineers demanded.

More Cherry blind rivets, echoed manufacturers of airplanes, radios, and home appliances.

Along with this increasing popularity came new applications, new conditions, and new problems . . . problems which could only be met by making the rivets of a new metal.

In some installations, this fastener had to be corrosion resistant and have great shear and tensile strength. In others it had to fight dampness, vibration and high temperatures.

Also, to produce the rivets on a high production basis, the metal had to be machinable . . . allow for turning and drilling. Finally, it had to be tough, yet ductile enough for the rivets to "upset" properly.

Quite an order for a single metal! Nevertheless, one metal did meet all those requirements. Its name? Monel.*

* * * *

The above is another chapter from the record of Monel . . . one of the INCO Nickel Alloys. Does it suggest an answer to your metal problems?

All of these high nickel alloys are strong, corrosion-resistant, tough, and workable.

In addition, each has special characteristics to meet specific problems such as high temperatures, flexing, abrasion, and oxidation.

TO AID YOU in obtaining the metal with the exact properties you need, send for the "Metal Selector Kit." Here is an adjustable comprehensive chart showing the chemical and mechanical properties of all the INCO Nickel Alloys. Also included is a 20-page booklet of comparative data concerning 104 ferrous, non-ferrous metals, and alloys. A request on your letterhead will bring this kit to your desk. Write today.

THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street, New York 5, N.Y.

NICKEL (INCO TRADE MARK) **ALLOYS** MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL • INCONEL* • "Z"* NICKEL • NICKEL

*Reg. U.S. Pat. Off.

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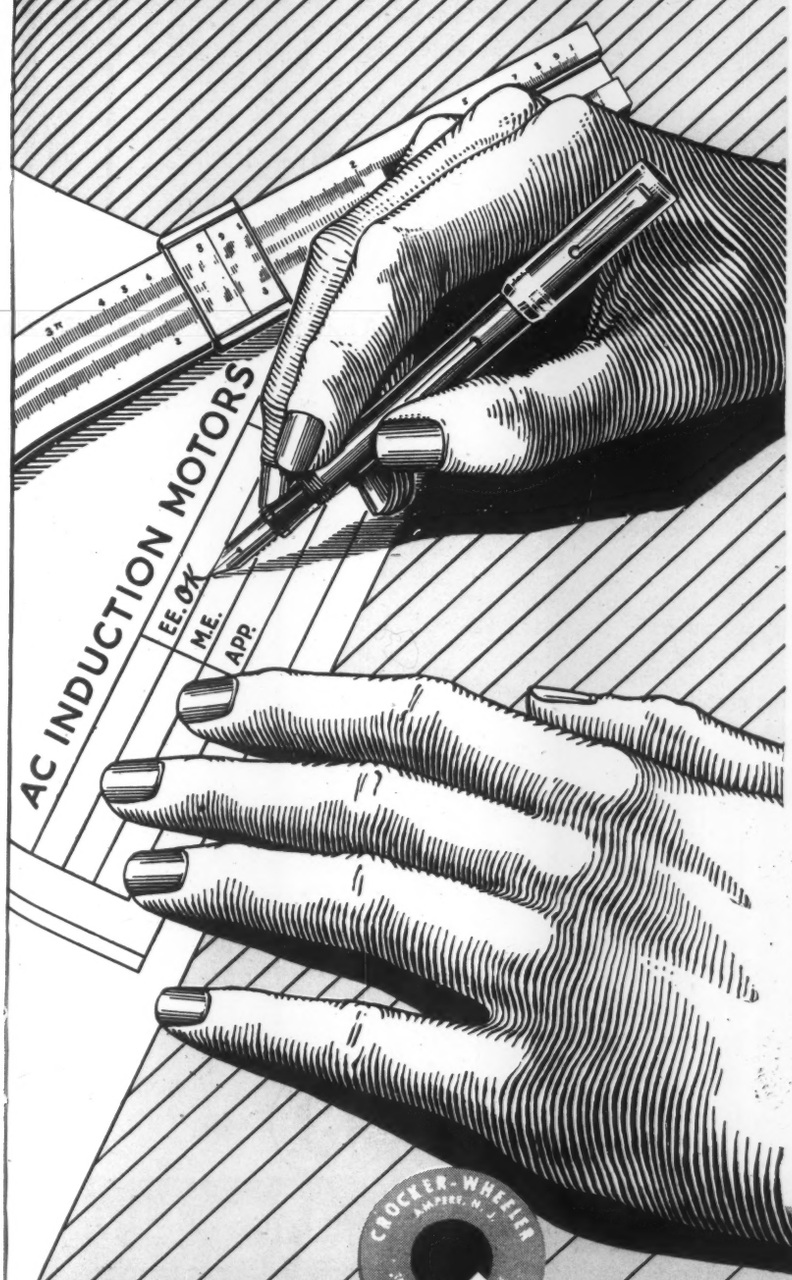

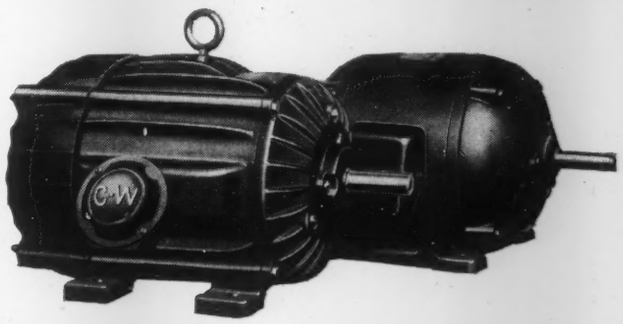

Crocker-Wheeler know-how, acquired through 60 years of manufacturing quality electric motors and generators, has broadened its horizons. A new ownership and management assumed control of this pioneer company during the war. This new management has developed Crocker-Wheeler's production and research facilities to match the recognized superior quality of its products.

Infused with modern methods, progressive management and millions of dollars for retooling, Crocker-Wheeler is now building in large quantity two great new lines of induction motors, combining the traditional Crocker-Wheeler quality and experience with manufacturing methods and tools as modern as tomorrow.

The New PROTECTED-TYPE BA and the New SEALEDPOWER-TYPE C (totally-enclosed, fan cooled) induction motors are only two of the improved machines Crocker-Wheeler has perfected with skill and knowledge gained from 60 years of background and experience . . . Built to do *your* job even better than before. CW-19

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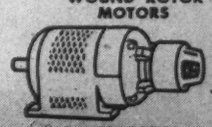
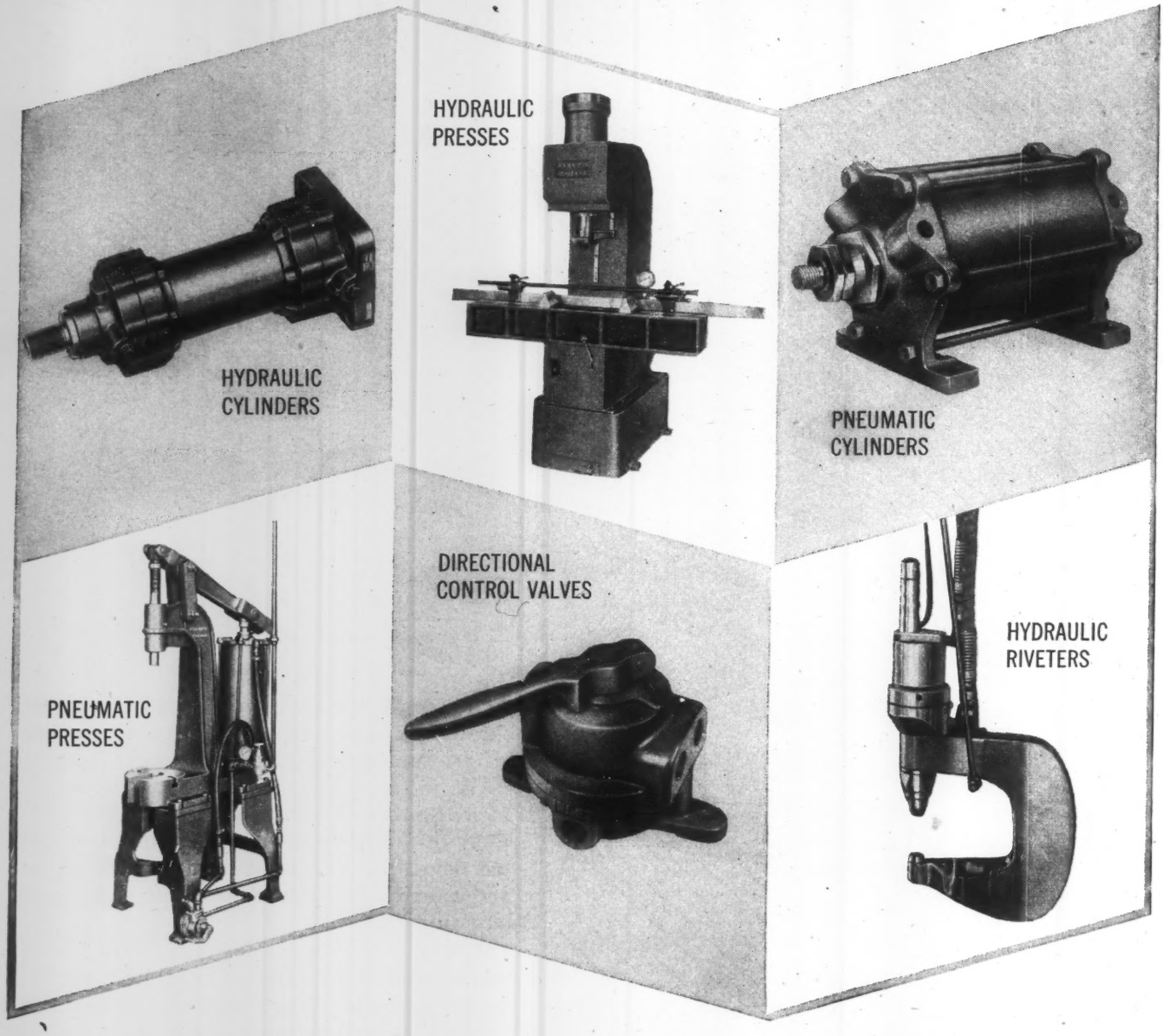

GENERATORS

FLEXIBLE COUPLINGS



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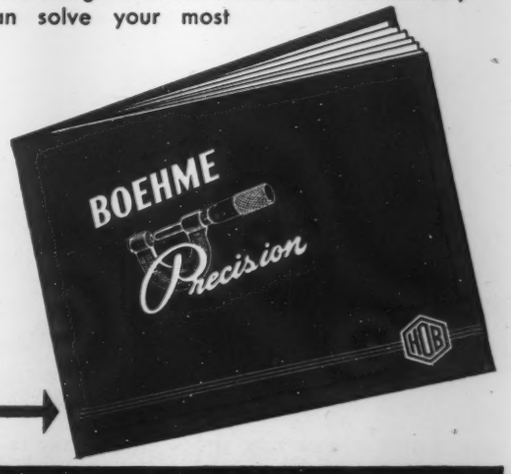
Learn more about this prompt, efficient, economical service, and how it readily applies to your needs, by reading this brochure. There is no obligation, of course.



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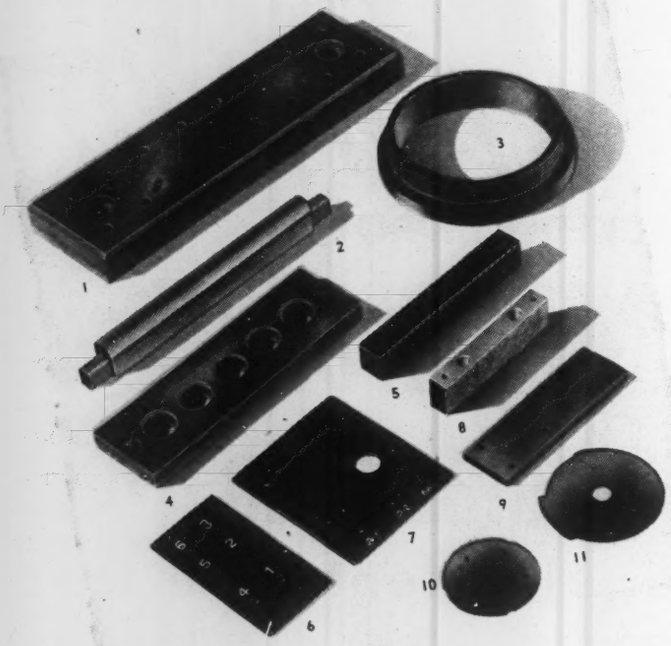

Hardly a day passes without our engineering department being faced with some new electrical insulation problem. That's the reason for the C-D research laboratories manned by technicians whose job it is to find the solution to your "different" problem.

A glance at the photo and variety of applications listed will give you some idea of the many problems solved by C-D non-metallics. These versatile materials were used to supply the exact combination of electrical and mechanical properties to do their specified jobs.

There is experienced, seasoned engineering help available to advise you on the performance, safety and economic advantages of using C-D non-metallics for electrical insulation. Get in touch with Continental-Diamond for the help you need.

1. High Voltage Dilecto Cabinet Barrier
2. Vulcoid Insulator for Lighting Switch Panel
3. Dilecto Conduit Insulation Fitting
4. Dilecto Dryer Switch Insulator
5. Dilecto Terminal Block
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7. Dilecto Insulating Plate
8. Fibre Baffle Plate Support
9. Dilecto Insulator
10. Dilecto Reverse Switch Insulator
11. Dilecto Switch Operating Disc

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DIAMOND VULCANIZED FIBRE

VULCOID—Resin Impregnated Vulcanized Fibre.

DILECTO—Thermosetting Laminated Plastics.

CELORON—A Molded Phenolic Plastic.

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Available in Standard Sheets, Rods and Tubes; and Parts Fabricated, Formed or Molded to Specifications.

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Bulletin GF gives Comprehensive Data on all C-D Products. Catalogs are also available.

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Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911— NEWARK 23 • DELAWARE

Now! "Tailored Speed" helps you simplify slow-speed machine design!

● One look *certainly* deserves another—especially at the compact lines of this American Reduction Drive! Here's modernity, simplicity—the kind of clean, space-saving design that adds up to volume sales. And here's how you can get the same results by giving your machines the advantages of "*Tailored Speed*"—with American Reduction Drives. American Reduction Drives mean *more* than just the right speed for the job. They save valuable space—the drives mount right on the shaft of the machine. Further, they're easy to install—and the need for special, bulky foundations or supports is eliminated. Combine all this with long, quiet, trouble-free operation and you've got a reduction drive that spells versatility, economy—*real* sales appeal!

"Tailored Speed" means versatility, too!

American Reduction Drives, with standard 13 to 1 ratio Reduction Units, deliver any required speed from 11 to 154 rpm.

Six standard sizes will handle jobs from ¼ to 25 hp.

You can easily get complete selection, application and installation data on American Reduction Drives, right now. Just drop us a line asking for your copy of the American Reduction Drives Handbook. It's your first step to real design simplicity on slow-speed equipment. A note from you is all that's required.

The American Pulley Company

4238 WISSAHICKON AVE., PHILADELPHIA 29, PA.

Topics

DRY-ICE PELLETS, when used in a tumbling barrel, remove flash from precision-molded parts of synthetic rubber or plastics. Thermal shock, coupled with abrasion from the pellets, removes all traces of the flash. Timing is not critical because the pellets evaporate. Only enough pellets are used to do the job.

WELDING ELECTRODES with metallic coating for low temperature welds have been developed by Eutectic Welding Alloys Corp. to improve physical properties of weld deposit, assist in surface alloying, and protect rod from corrosive attack.

MAGNETIC INSPECTION on an automatic basis has been incorporated in a machine developed by Magnaflux Corp. In a machine for nondestructive inspection for flaws in crankshafts and camshafts, either circular or longitudinal magnetization is accomplished to conform to inspection requirements.

NEW ALLOY has been perfected by the Elgin National Watch Co. for use as mainsprings. The alloy is rustfree in high relative humidities, is impervious to perspiration, is nonmagnetic and will outlast by four times the best steel with respect to breakage from stress.

BUILDING ATOM SMASHERS on a commercial basis is now an actuality according to the General Electric Co. A 100,000,000-electron volt betatron machine is being built for the Clinton Laboratories, operated by the Monsanto Chemical Co. for the Atomic Energy Commission. Another similar machine is being constructed for the University of Chicago where it will be used for nuclear research.

TRUCK TIRES with 12-ply all-nylon carcass have 50 per cent greater strength than 12-ply rayon tires of comparable size, according to The Goodyear Tire & Rubber Co. In addition, the nylon tire is more flexible, develops less heat in high-speed operation and is more bruise resistant. The nylon cord is prestretched before use, reducing its tendency to "grow" in service.

MANY NEW CIRCUITS for communication equipment such as radar and loran are proving useful in the industrial field. Square-wave circuits, clippers, blocking, timing, and counting, normally associated with radar have an important place in electronic circuits for register control, etc.

AIRCRAFT RADIO LANDING system developments have been accelerated during the past year through the use of helicopters. Personnel of the electronics subdivision of the Air Materiel Command use the craft as a "sky hook" for extensive tests to determine the exact pattern and range of the radio beams from the ground localizer and glide path transmitters.

PRESS-WELDING apparatus for fabricating radiators, developed by Adam Opel automobile factory in Russelsheim, Germany has been brought to this country for tests. Folded metal is placed in the welder betwen dies, heated and squeezed. Where dies match a seam is welded. Hot air is forced between the sheets to form a series of connected tubes.

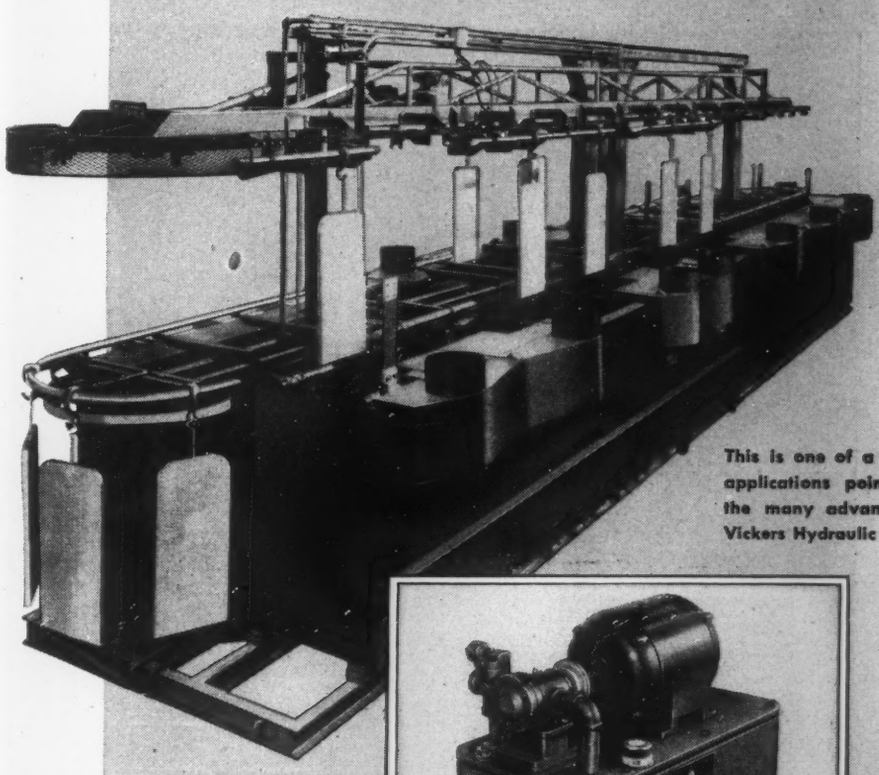
STRAIGHT AND PARALLEL flight lines may be flown with the aid of an indicator developed for use in aerial mapping and charting. Conceived and designed by the Army Air Forces, the instrument combines the electronic and mechanical operations of Shoran equipment and the indicator. Shoran was developed during the war as a means of precision bombing.

SYNTHETIC LUBRICANTS were reported as satisfactory for heavy-duty all-weather service as a result of tests with commercial delivery trucks, tractors, and other heavy-duty vehicles. Covering a greater range of temperatures with a single grade and reducing carbon formation, the synthetics give at least double the oil mileage in all classes of service and greatly facilitate operation in cold weather.

VICKERS helps achieve HYDRAULIC EQUIPMENT

HIGH PRODUCTION
SPACE ECONOMY
UNIFORM QUALITY

IN *Udylite* AUTOMATIC PLATING MACHINE



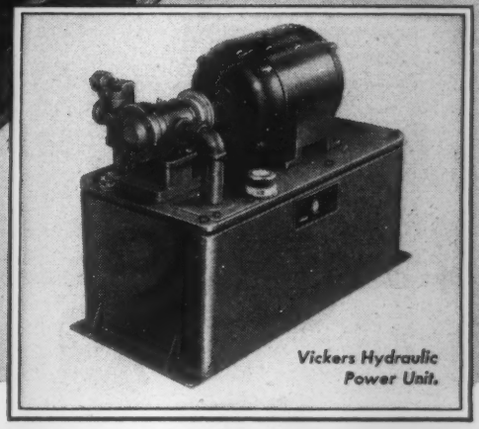
This is one of a series of applications pointing out the many advantages of Vickers Hydraulic Controls.

This Udylite machine does a complete plating job automatically . . . taking each part through seven tanks and a drying chamber . . . timing exactly the interval in the various solutions for cleaning, plating and rinsing.

Each part (or rack of parts) is automatically lowered into each of the seven tanks in turn—then lifted out and transferred to the next tank. This might be done with a multiple dip conveyor. But the conveyor slants permissible in lowering and raising in that way require extra tank length.

Udylite made the machine far more compact—saving 18″ to 24″ in the length of each tank—by using Vickers Hydraulic Equipment to raise and lower the entire conveyor assembly at each transfer. By this means, each piece (or rack) is lifted straight out of the tank, moved over the next tank and lowered straight down. This provides better cleaning and more uniform plating—better drainage and less contamination of the solutions.

Above: Elevated position for transfer from one tank to the next.



Vickers Hydraulic Power Unit.

The Vickers Hydraulic Power Unit and Control Valves have many advantages for such applications: (1) proven dependability, (2) accurate control and precise timing, (3) flexibility of control to suit varied production requirements, etc.

The versatile features of Vickers Hydraulic Equipment on this type of application, as on many other industrial installations, have made possible increased production, improved product quality, greater safety, and lessened physical demands upon labor while increasing its productivity. Vickers Application Engineers will gladly discuss your individual control problems.

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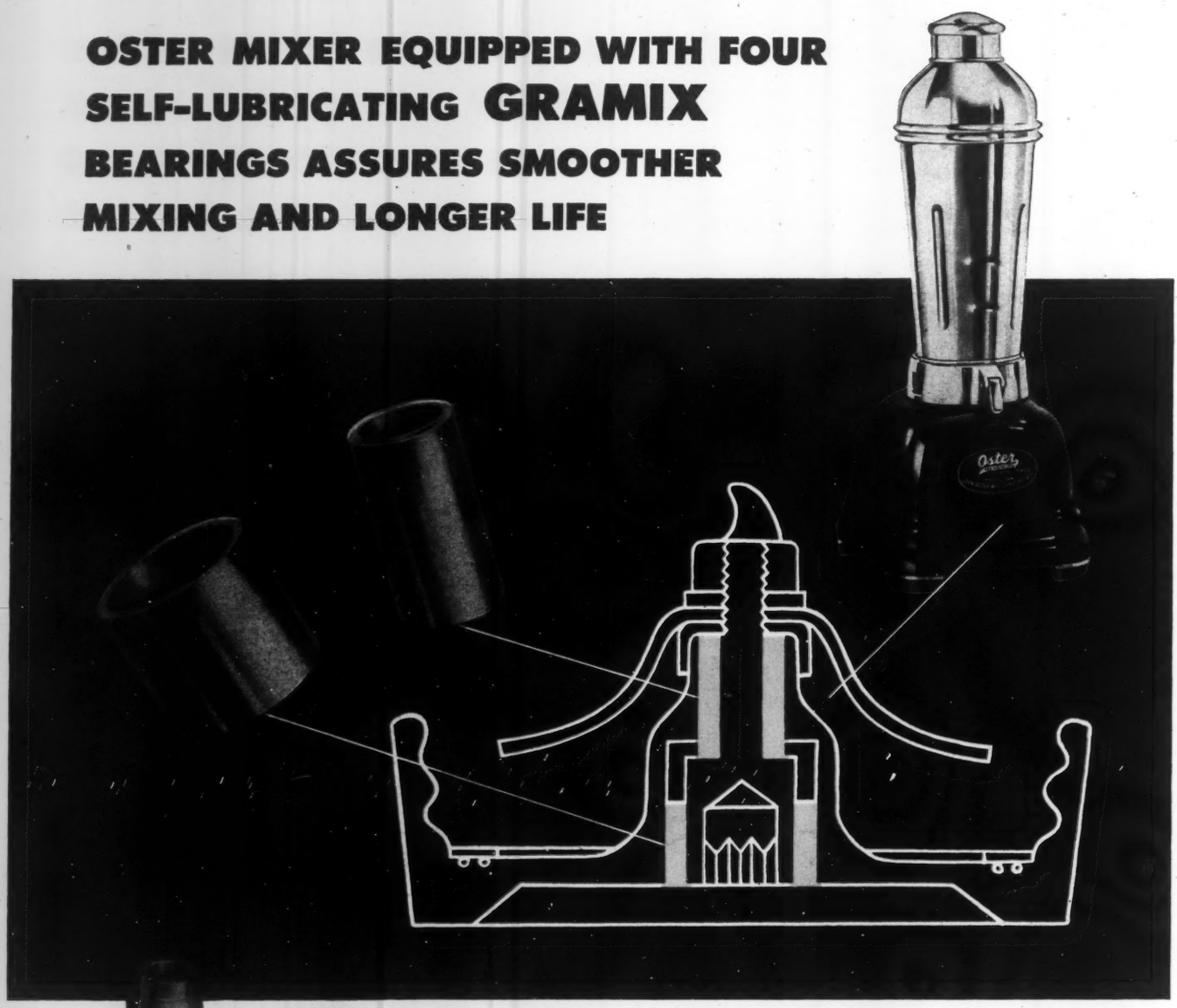
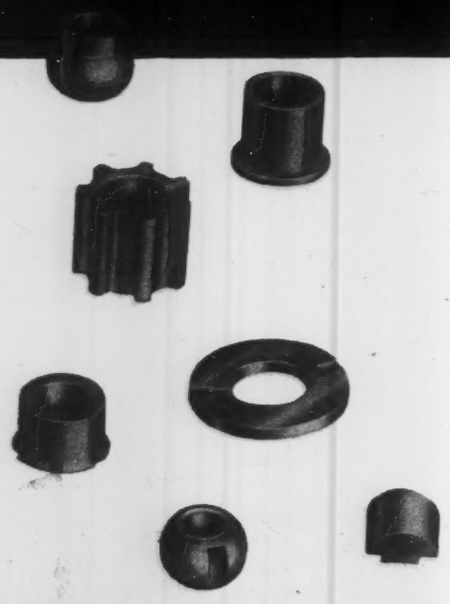
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

R_x FOR A BETTER MIXED DRINK

OSTER MIXER EQUIPPED WITH FOUR SELF-LUBRICATING GRAMIX BEARINGS ASSURES SMOOTHER MIXING AND LONGER LIFE



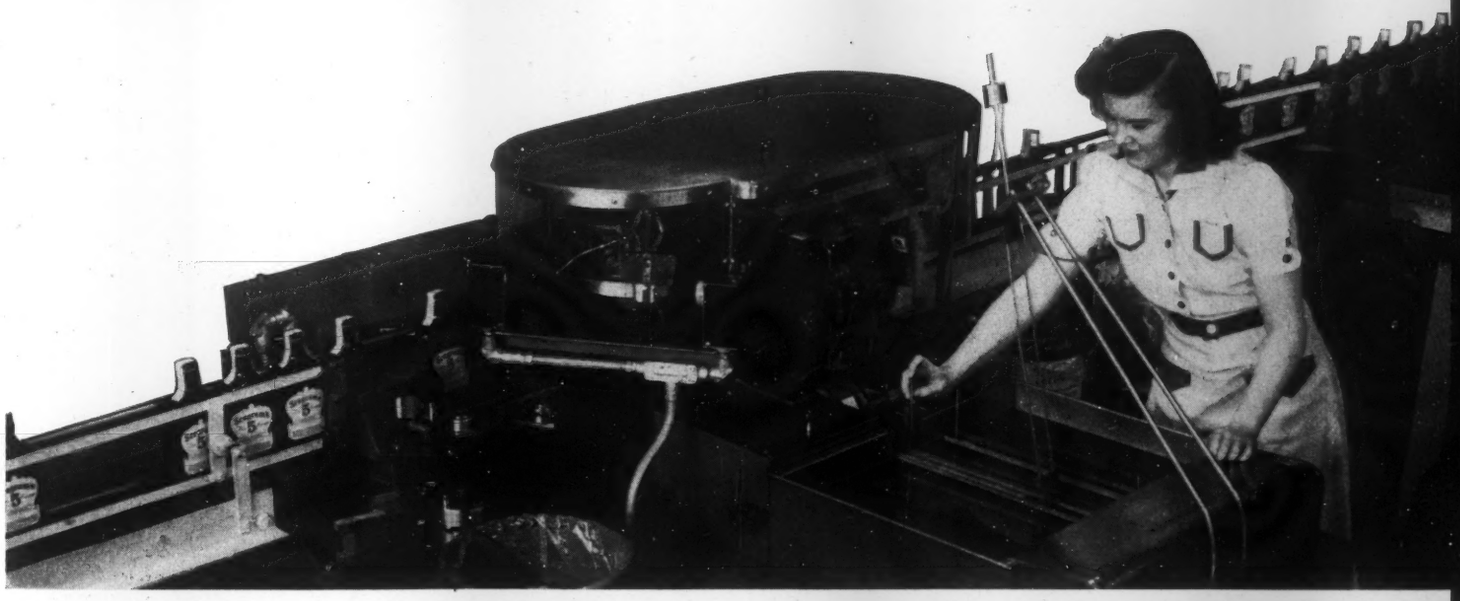


That luscious drink isn't so far from your own mechanical design problems as you might think at first glance. For example, the rotating shaft of this John Oster Mfg. Co. mixer operates faultlessly at top speed because it is held in Gramix powder metallurgy bearings. The two motor bearings are also Gramix. Gramix bearings, washers and other parts are low-cost, because they are die-pressed to extremely close tolerances— eliminating expensive machining and finishing. They have perfect bearing and sliding surfaces which provide smooth performance in scores of products. Gramix parts, due to their porous structure, are impregnated with a lubricant that in many instances makes further lubrication unnecessary. Send us sketches of your products. Our engineers may show you where Gramix parts will improve mechanical performance and save you money.

gramix

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

MACHINE DESIGN



Automatic Sealing Machine

. . . is designed for straight-through handling of containers and to approximate manual motions

By George E. Tcimpidis
Gisholt Machine Co.
Madison, Wis.

FROM the earliest days of packaging the bottling industry has wrestled with the problem of properly closing the open end of a container to effect a leak-proof, air-tight and tamper-proof seal which would be both economical in application and acceptable to the purchaser.

One of the newer ideas in this direction involves the use of a cellulose seal or band, in conjunction with a stopper, cork or cap. The seal is an extruded wood-fiber product which is kept in a liquid from the time of manufacture to the point of application. When it dries, it shrinks 30 per cent or more in size. Thus, after it is applied it shrinks over the neck and cap forming a positive seal. Because the seal cannot be removed without cutting or otherwise destroying it, it is tamper-proof. The seal can be produced in many colors and with the bottler's name, trademark or slogan imprinted.

To take care of the many different neck and cap di-

Fig. 1—Simulating manual application methods, sealing machine automatically applies cellulose bands over bottle

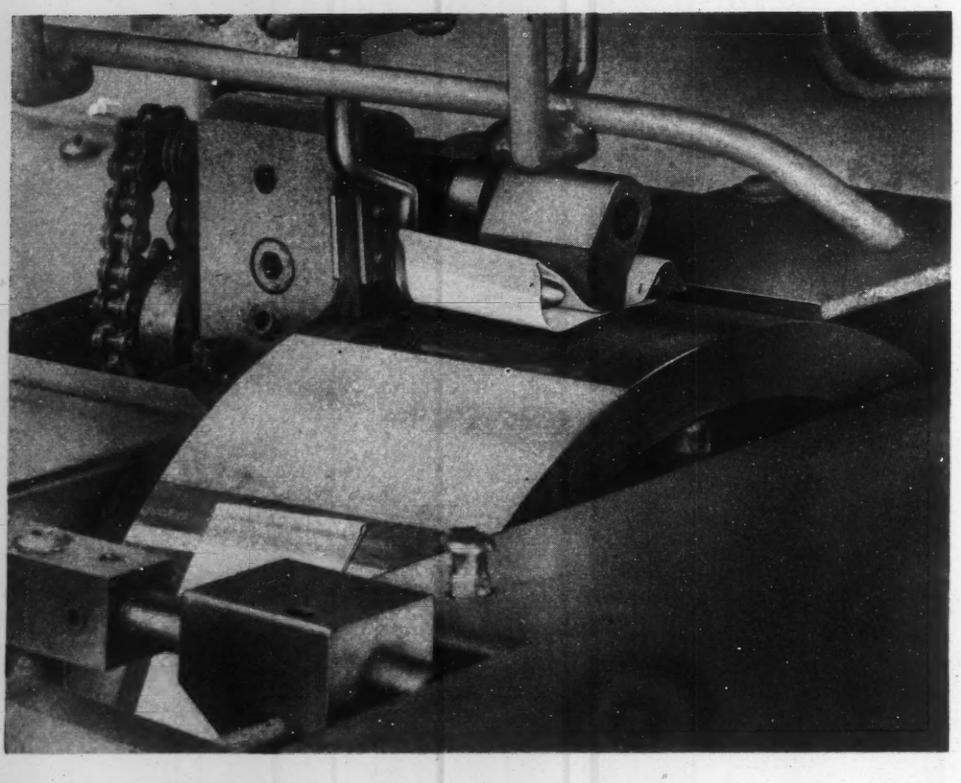


Fig. 2—Pick-up drum with seal opened by rotary rubber finger preparatory to transfer to the pick-up fork

ameters as well as lengths, the seals are made in a number of sizes. To prevent drying before application, they are packed in metal containers in a liquid which is principally water and glycerine with other preservatives.

Until recently, these seals have been applied by hand to the bottle necks. The large number of operators required made the operation relatively costly and prevented the use of seals on inexpensive items. Nonuniformity of application of the seals to the bottles detracted from their appearance and advertising value and in fact sometimes hampered their sealing function. Also, the speed of the bottling line, for the most part mechanized, was held down by this operation which could not be speeded up except by adding more operators.

Shuttling Motions Should Be Avoided

Early experiments in producing a machine to replace the hand method made no attempt to copy the manual movements in applying the seal; actually entirely different motions were tried. The machine made the bottles follow a U-path. They were picked from the conveyor as they came along, deposited at the sealing position of the machine and held stationary while an applying head shuttled back and forth to perform the sealing operation. Then the bottles were pushed back onto the conveyor. All of this was accomplished by a number of reciprocating and intermittent motions.

These early experiments proved that intermittent and reciprocating motions should be avoided in handling bottles because the consequent roughness of bottle motion precluded high-speed operation. It appeared, therefore, that a straight-through movement of the bottles and an applying method approximating manual operation would be easier on the bottles if, at the same time, speed and accuracy of the operation could be improved.

With these goals in mind the machine shown in *Fig.* 1 was evolved. Bottles pass through it in a continuous motion which handles the bottles gently. Speed of operation is not critical, the machine being capable of greater speed than any present bottle line. Accuracy and uniformity of application of the seals surpasses hand methods.

One operator handles the machine, replacing as many as six to eight formerly required. She fills the magazine trays from the containers in which the seals are stacked by the manufacturer. The magazine trays rest in a tank containing a preservative solution to keep the seals from deteriorating or drying before application to the bottle neck, an important feature of the machine because of the fast drying characteristics of the seals. There are two magazines, one in use and one in reserve. As a magazine is exhausted, the operator slides the reserve magazine into position without interrupting the operation of the machine, there being a sufficient quantity of seals in a fixed chute feeding the pick-up drum to keep the machine supplied during changeover. A pendulum weight, seen in *Fig.* 1, gives a uniform feed pressure in the magazine except during magazine changeover. At that time, jets of water impinge on the seals in the fixed chute to hold them in place until the magazine is changed.

Vacuum Utilized to Pick up Seals

At the end of the fixed chute, a pick-up drum, having an intermittent rotary motion, strips the seals from the magazine one at a time. Vacuum, applied to a series of holes in the drum, separates the end seal from the balance of the seals in the magazine, causing it to adhere to the drum. As the drum indexes to the next station, the seal slides clear of the adjacent seal in the magazine and is carried around with the drum.

Considerable research and development work was

necessary before this pick up from the magazine was perfected. The natural "stickiness" of the seals had a tendency to prevent them from being picked up by the drum one at a time. Also, the slightly rolled edge of the seal in its flat shape tended to hook onto the seal just ahead of it in the magazine. The result was that the drum often picked up two seals at a time instead of one. Also, the seals tended to cling to the sides of the magazine tray so that they failed to feed forward in sufficient quantity, or else they "skewed" sidewise in the tray out of parallel with the face of the pick-up drum.

It was found possible to insure feeding the seals properly along the tray by hinging one wall of the tray and oscillating it slightly all the time. This action is much the same as tapping the edge of a pack of cards against a table top to straighten them out. With this motion the seals have no tendency to stick to the walls of the tray or to skew sidewise. To prevent more than one seal at a time from being picked up by the drum, a "tamper" was devised, consisting of a narrow blade mounted over the top of the seals near the drum. Again using the analogy of the card player, this tamper moves up and down, tapping the seals the same way one takes a finger and taps down across a pack of cards standing on edge to straighten them. The tamper does more than this however; the end of the blade clears the drum a distance equal to slightly more than the thickness of one seal, but not as much as the thickness of two. The tamping action is timed with the drum index so that, at the moment of pick up by the drum, the tamper is resting on all the seals nearest the drum except the one immediately adjacent to it. Therefore only the seal next to the drum can be picked up.

Opens Seal with Rubber Finger

The seal, still a flat object, has now been removed from the magazine and must be opened for application. This is done by a rotary rubber finger located at the station following the pick up from the magazine. With the seal in position on the drum, this finger, *Fig.* 2, slides the top half of the seal over the bottom half much as the thumb slides one page of a book over another. Since the bottom half is still held by vacuum, this sliding motion forms a loop on each edge large enough to permit the

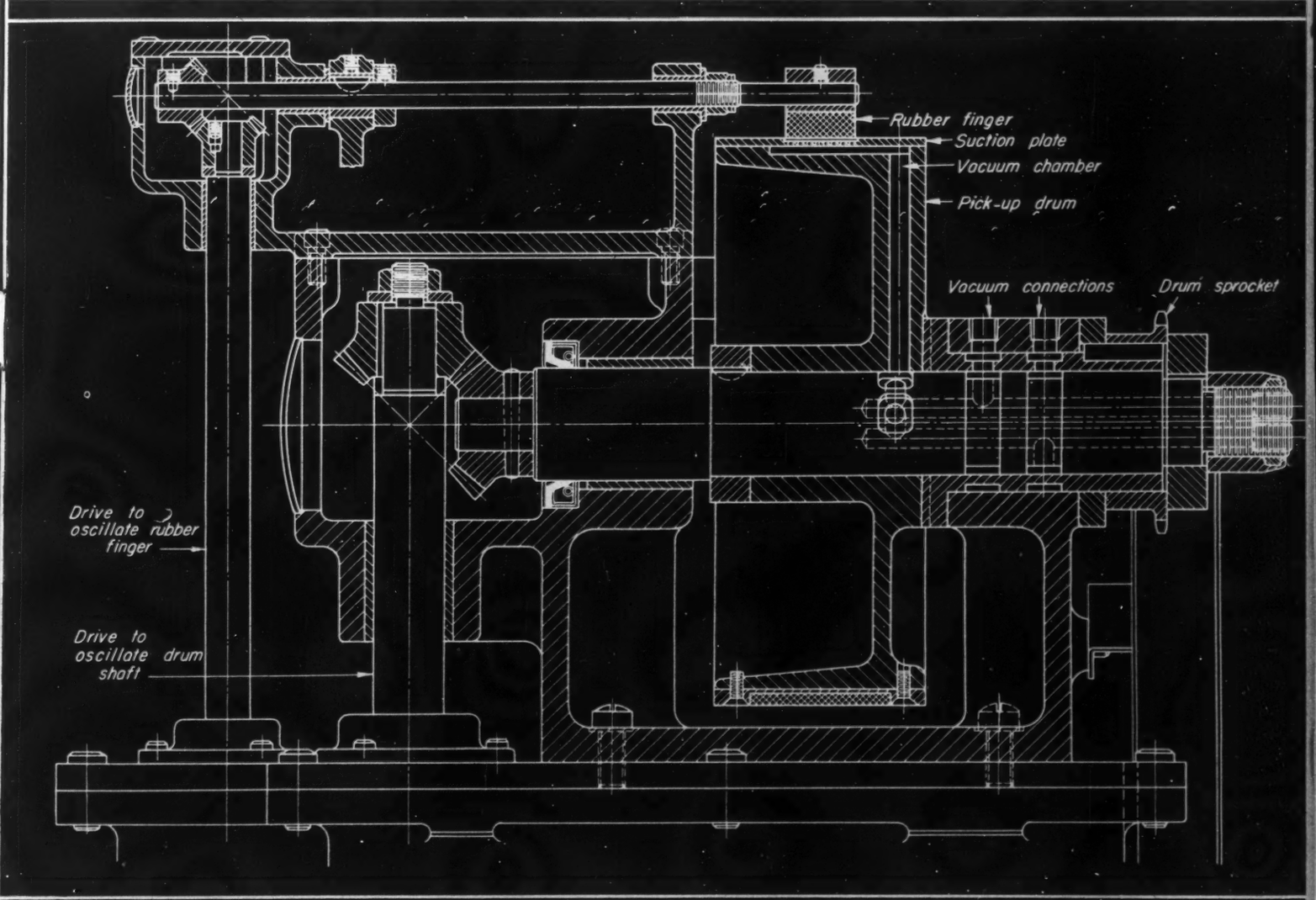


Fig. 3—Section through pick-up drum showing the suction ports, rubber finger and oscillating drives

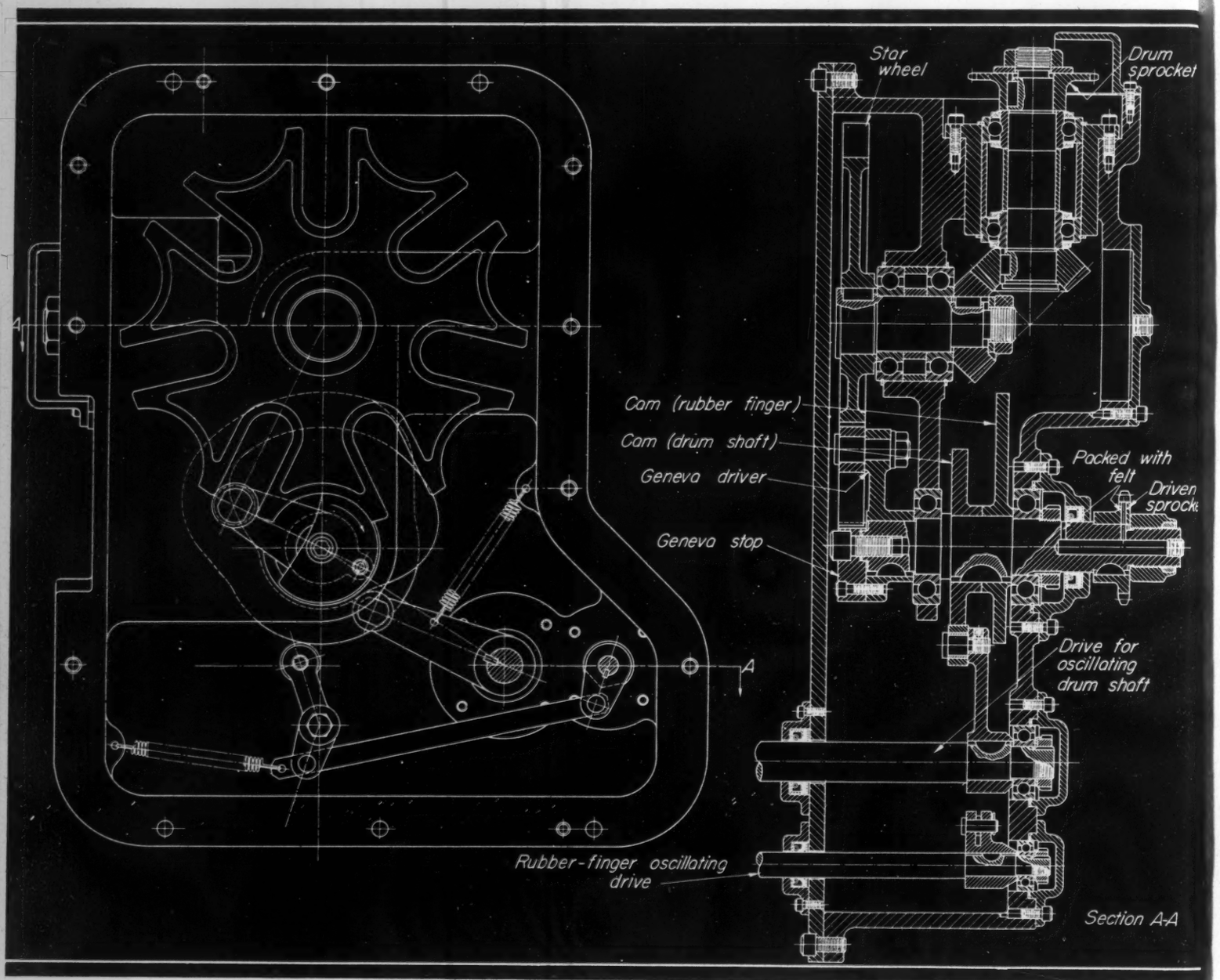


Fig. 4—Geneva indexing unit for pick-up drum

prongs of the pick-up fork to enter and remove the seal from the drum.

A section through the pick-up drum in shown in *Fig.* 3. The drum is a nickel-alloy casting and the drum shaft is stainless steel, turning in Oilite bearings. The chain sprocket at the right indexes the drum through seven successive stations from a Geneva type index while the drum shaft and opening finger are oscillated by the bevel gears at the left which in turn are operated by cams and levers from the Geneva index unit shown in sectional view in *Fig.* 4.

Wick Lubricates Chain

This unit is ball bearing mounted and operates in an oil bath. It is of conventional design with the Geneva starwheel made of hardened alloy cast iron. Lubricant for one of the chain drives is wick fed through a drilled hole in the chain sprocket.

The pick-up fork, shown in *Fig.* 5, consists of a small carriage supporting two slidable cam-operated prongs attached to a roller chain. The chain carries the prongs past the pick-up drum where they slide into the seal and remove it from the drum. After leaving the drum, the prongs are expanded by cams to stretch the seals slightly and permit the applying head to enter the seal.

Another chain-driven unit carries the applying head which travels over the pick-up mechanism at twice the speed of the pick-up. Thus, at fixed intervals, an applying head overtakes a pick-up head and strips the seal from it. An applying head contains eight rack-operated expanding fingers. After the head has taken the seal from the pick-up fingers, a fixed cam causes the eight fingers to expand the seal to approximately the diameter of the bottle neck. While the head is being carried by the chain around to a position over the bottle conveyor, a further cam

indexes the head to a vertical position so that the seal is ready for placement on the bottle.

At this position the chain has carried the head directly over a bottle which is traveling on a conveyor synchronized to run at the same speed as the head. The bottle is positioned on the conveyor by holding fingers, and centered with the head by a V-shaped centering bracket, *Fig.* 6. When the head is at this point, a cam operates a stripper plate, pushing the seal onto the bottle neck to a predetermined height. The conveyor then carries the bottle clear of the machine, and the applying head moves on to start a new cycle. Clinging to the bottle neck the seal remains in position until it drys, after which it can be removed only by destruction.

Stationary Cams Operate Fingers

Construction of the pick-up fork is shown in *Fig.* 7. There are four of these assemblies mounted on a chain drive, and, as previously mentioned, operated by stationary cams to open and close the fingers at the proper time. If a seal fails to open properly when the opening finger slides over it to form the pick-up loops, the fork will not pick up the seal. Were the seal to remain on the drum and index with it, it might cause trouble. This is prevented by a simple device. At the back of the pick-up fingers there are small Neoprene wipers similar to an automobile windshield wiper in cross section. If the finger fails to pick up the seal, the wiper in the rear will come by and push the seal off the drum and onto the frame of the machine where it will do no harm.

Design features of the head which applies the seal to the bottle are shown in *Fig.* 8. There are six of these units attached to a chain which carries the head past the pick-up forks at the front of the machine and then around to the rear and past the bottle line. Three different functions are incorporated in the head. First, it must index from horizontal to vertical and then back to horizontal in picking up the seal and bringing it to the applying position. Second, the fingers must close to a flat thin shape to pick the seal from the pick-up fork, and afterward they must open to approximately the size and shape of the bottle neck to prepare the seal for application. Third, the stripper plate must push the seal from the fingers onto the bottle neck. These movements of the continuously moving head are all accomplished by stationary cams along the path of motion. A double rack-and-pinion mechanism operates the actual opening and closing of the fingers. Design of the stripper mechanism shown in the drawing

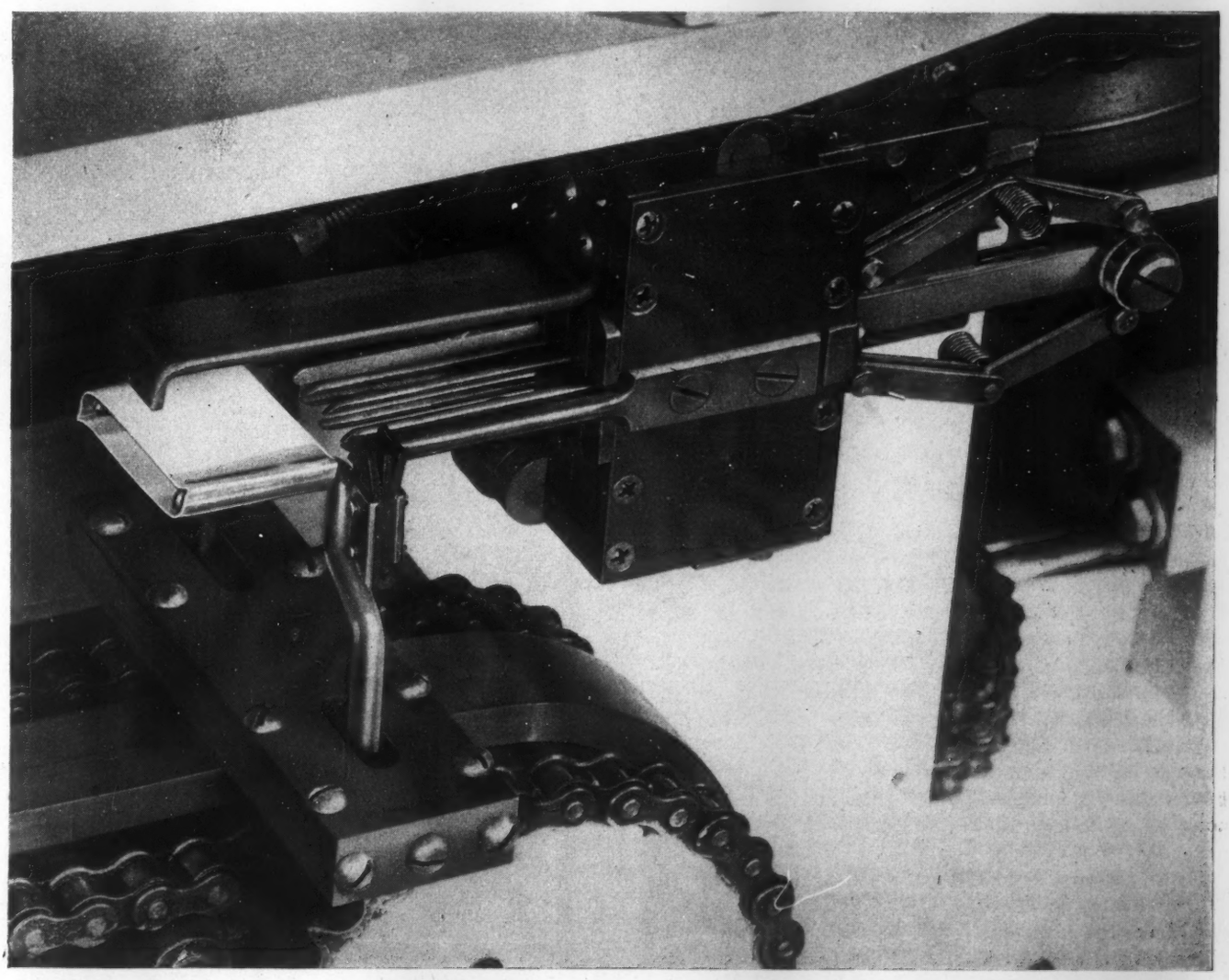


Fig. 5—Pick-up fork is attached to roller chain. Fork is expanded by cams after it removes seal from drum

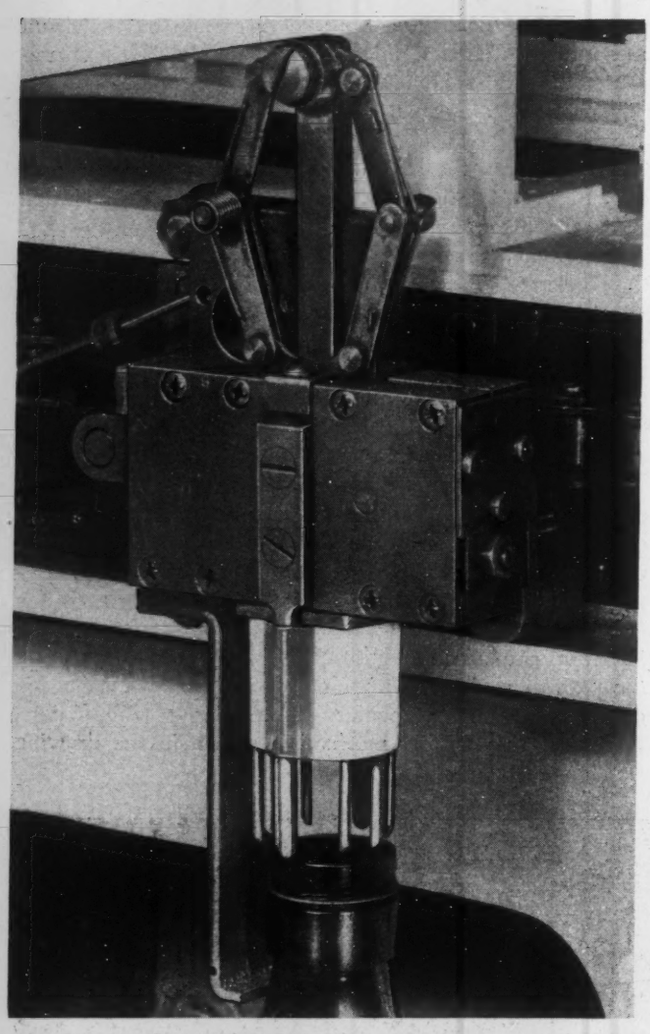


Fig. 6—Applying head in position over bottle. Head has been rotated to vertical position and cam-operated stripper is pushing seal onto bottle

differs slightly from that shown in the photographs *Figs.* 5 and 6.

Operating efficiency of the machine is extremely high because of the interlocking controls that have been provided. The bottles enter the machine via a starwheel shown at the lefthand side of *Fig.* 1. Its purpose is to space the bottles at a definite distance apart in going through the machine. In normal operation, with a conveyor line full of bottles, it runs continuously. Should the conveyor line at any time fail to deliver sufficient bottles to the machine, the machine would begin to waste seals by stripping them off where there were no bottles. To prevent this, a normally-open limit switch at the starwheel is closed every time a bottle passes. The impulse from the limit switch actuates a solenoid-operated single-revolution clutch which in turn operates the pick-off drum through one index, thus picking up one seal. When no bottles are fed into the machine, the pick-up drum does not operate and, therefore, no seals are taken from the magazine.

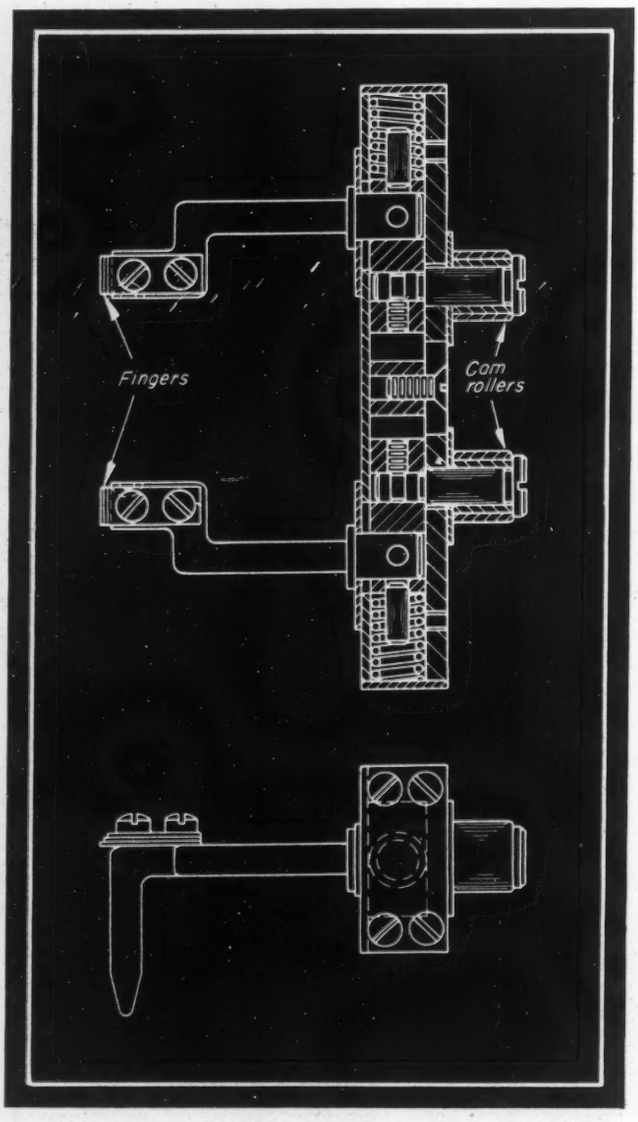
Seals have occasional dimensional imperfections and cause the pick-up drum to miss a station. This condition would normally allow a bottle to pass through the machine without receiving a seal if there were no safeguard to prevent it. To meet this possibility there are two electrodes or probes spaced about a half-inch apart and arranged so that the seal on the pick-up fingers wipes past them.

At this same moment a cam closes a normally-open limit switch. A small amount of current will pass from one electrode to the other through the wet seal and, being amplified by an electronic relay, will actuate a solenoid-operated single-revolution clutch driving the starwheel, causing it to make one cycle and feed one bottle into the machine.

Provides Adjustments for Various Containers

Adjustment of the machine to handle varying heights of bottles is done by having the upper portion mounted on a sub-base which is screw adjustable in relation to the base. This keeps the base of the machine in fixed relationship to the conveyor line in which it is set, but permits adjusting the seal applicators up or down to match

Fig. 7—Below—Construction details of pick-up fork. Stationary cams open and close prongs of fork at proper positions as it travels on its roller chain



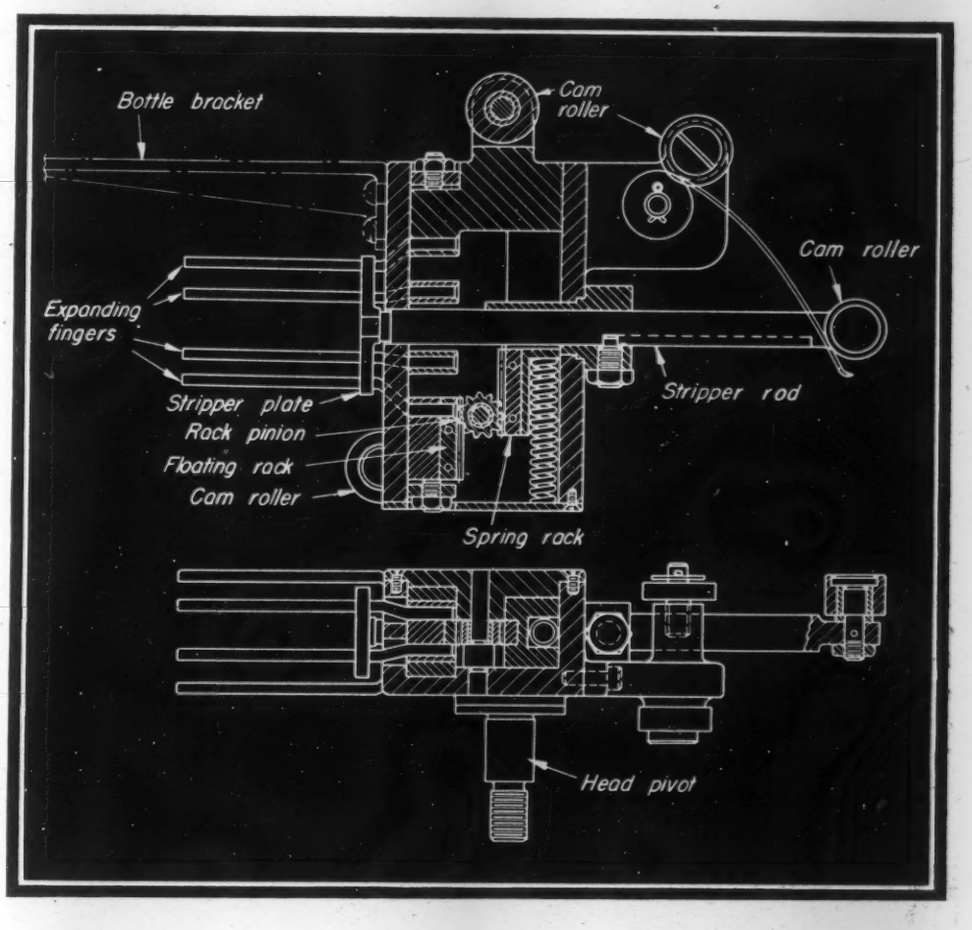


Fig. 8 — Applying-head construction. Fingers operated by stationary cam close flat when receiving a seal and open to size of bottle neck for application. Stripper pushes seal onto bottle

the bottle height. This adjustment is by a crank at the front.

Differences in length and diameter of various seals are provided for by changing cams for the eight-finger head and, in some cases, by changing the fingers. All changes for different seal and bottle sizes are simple in nature and are made quickly.

Synchronizing of the machine speed to the conveyor speed is accomplished by adjusting the variable-speed drive unit. For this machine, the V-belt variable-pitch pulley type was found to be satisfactory, adjustment being readily made by a handwheel at the front of the machine.

Vacuum Pump Is Rotary Type

It is obvious that a good vacuum source is essential to successful operation of this machine. A stainless-steel rotary-type pump is used, and a small amount of the water-glycerine solution is bled from the tank magazine to act as a seal and lubricator. With this arrangement, a vacuum of 26 to 28 inches can be maintained continuously without any trouble.

Since the machine is used in packaging beverages and foods, it is designed to have a clean, sanitary appearance. The major parts of the machine are stainless steel, nickel iron, or chrome-plated brass or bronze. These will not stain from the solutions used around the machine and are easily cleaned. Corners are rounded to avoid trapping of dirt, and the machine is made so that it can be washed easily.

Lubrication of machinery of this sort is often a problem because of the tendency by the operating personnel to overlook it, or of the possibility of excessive lubricant soiling the machine or the product. To avoid this the machine was made practically self-lubricating. Most of the bearings are grease-sealed ball bearings or oil-impregnated bronze. There are only six places requiring manual lubrication and they are serviced by a single centralized pressure grease fitting.

Motors, pumps, drives, etc., are mounted within the lower base and are accessible through flush doors in the sides of the machine. The inside surfaces of the base are sprayed with white lacquer for its sanitary appearance and to improve visibility when servicing equipment inside the base.

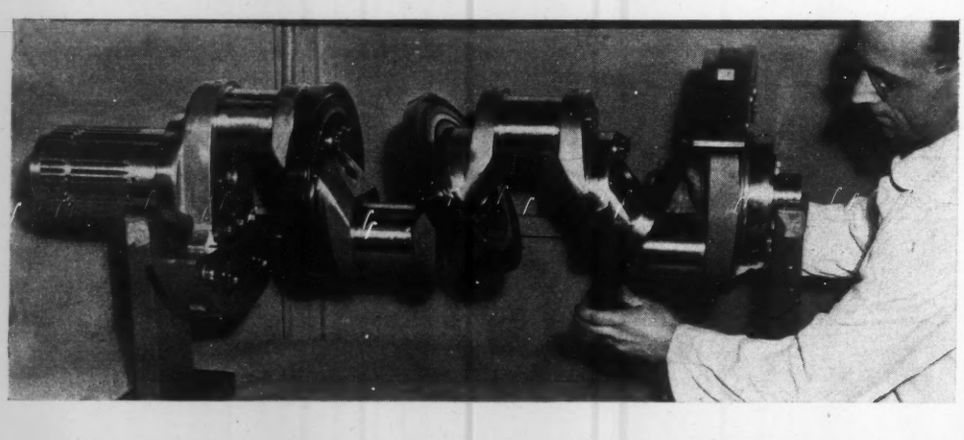
Styling of the machine is functional and modern but not extreme. The sheet metal enclosures are sprayed a soft color which harmonizes with the customer's packaging department. A large, clear plastic guard tops off the machine, serving to protect the operator from the applying heads, yet permitting full vision of the mechanism as well as displaying the machine operation and the company name.

CORRECTION: On Page 182 of the March issue, in the article on "Cyclic Variation in Speed," it is stated that, at the instant the velocities of the driven and driving members are equal, $\cos KA = N$ for both internal-gear and spur-gear types of cranks. The equation is true only for the spur gear. For the internal-gear type the equation becomes $\cos KA = -N$.

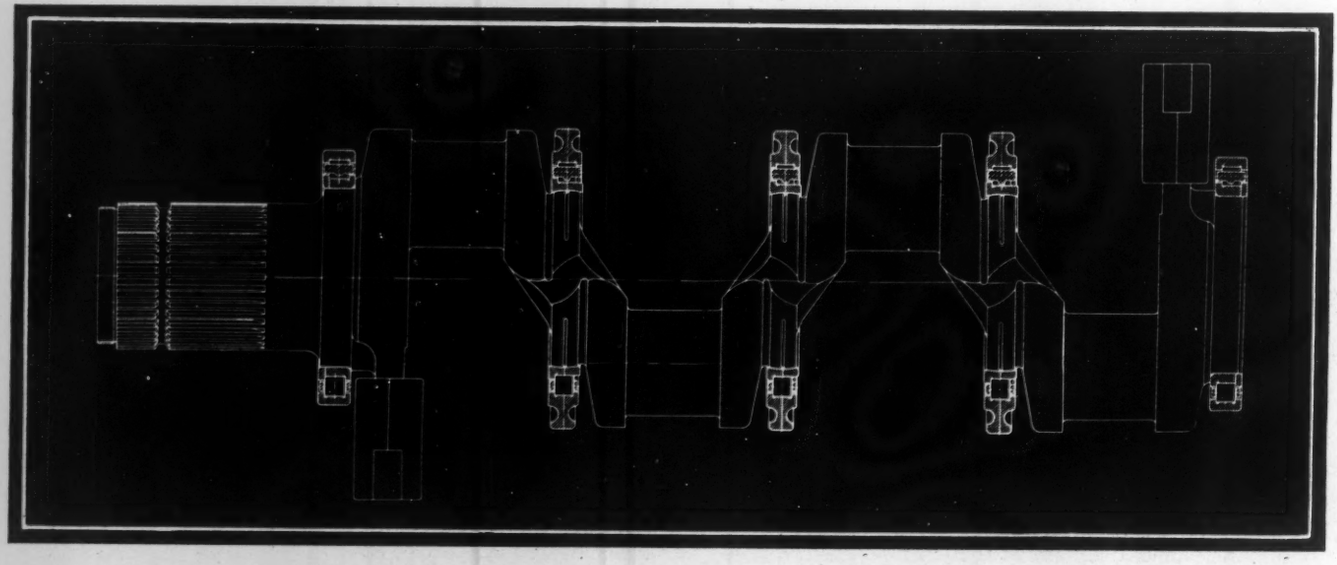
Scanning THE FIELD for Ideas

ANTIFRICTION bearings of an entirely new design are credited with aiding developers of the 5000-horsepower XR-7755, world's largest reciprocating aircraft engine, to attain a highly favorable ratio of power to weight. Inner rings of the cylindrical roller bearings supporting the crankshaft are sphered or concaved in the bore so that they can be positioned on the mating sphered seats of the crankshafts as shown below, thus axially restraining the bearing assembly after mounting.

These bearings, developed by SKF Industries Inc. for the Lycoming Division of The Aviation Corp., eliminate the need for locking devices, a feature that makes the design more compact and reduces weight. The crankshaft is constructed in separate sections so that the intermediate bearings can be assembled along the axis of the crankshaft throw, then cocked into place to permit the bearing axis to coincide with the axis of the assembled crankshaft.



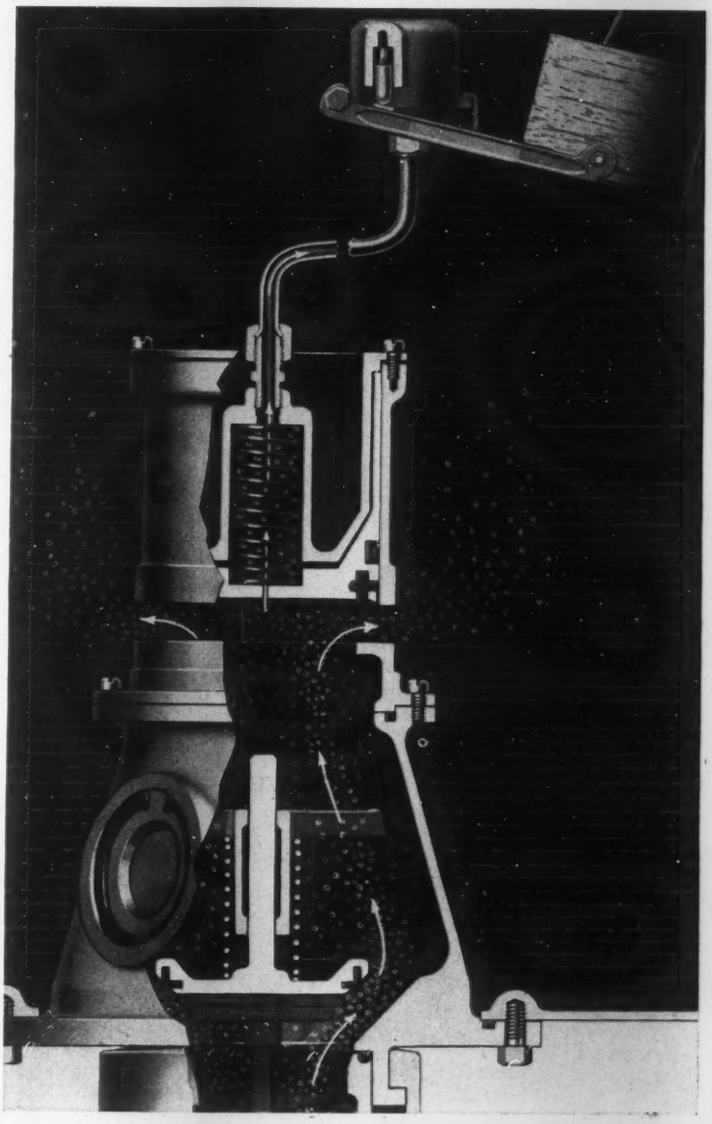
Sphered inner rings have approximately 0.0020-inch loose fit on the crankshaft. The relative motion of these loosely fitted surfaces is taken care of by lubricating oil supplied through the crankshaft and distributed by circumferential oil grooves on the crankshaft



seat. Each bearing is one foot in diameter, slightly more than an inch in width, and weighs less than fifteen pounds. Despite their compactness they are designed to withstand normal loads of 15,000 pounds and instantaneous peak loads approximating 100,000 pounds.

Rollers are crowned to prevent high load concentrations at the roller ends. This crowning has the added advantage of permitting the bearing to operate satisfactorily under minor misalignments which are practically unavoidable in highly stressed aircraft engines.

Bearings have a one-piece bronze retainer with broached roller pockets and with the cage centered by the outer ring flanges. This construction permits the assembly of a larger number of rollers than is possible with the conventional two-piece riveted cage and experience has demonstrated that the one-piece retainer is relatively stronger and more reliable for aircraft usage. To minimize corrosion and to aid the wearing-in of the sphered bores, the rings and rollers are coated with a black oxide.

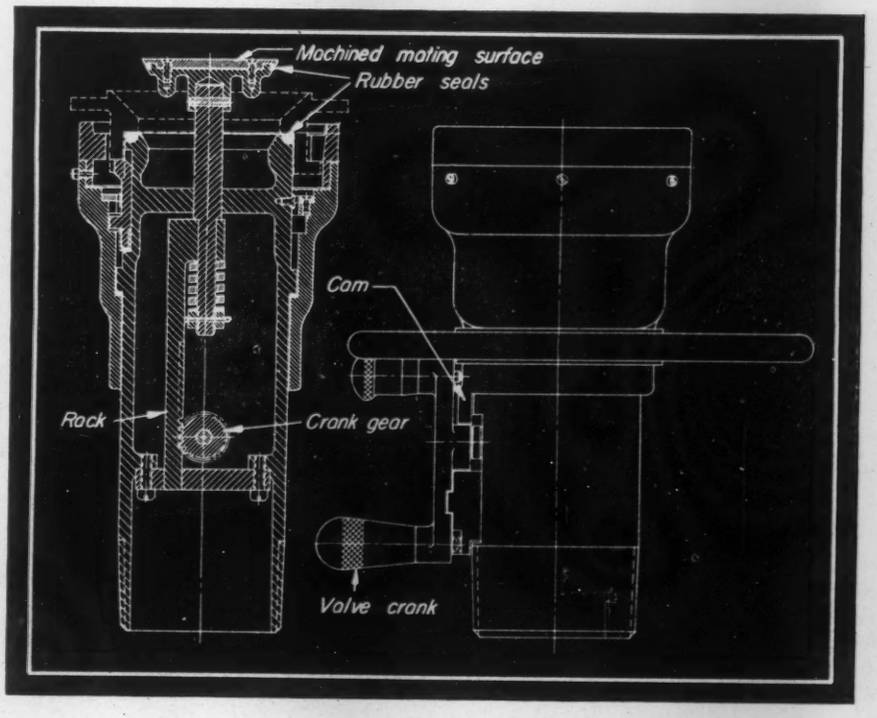


Two-part valve, illustrated at right, is an answer to the problem of fueling aircraft tanks "from the bottom up", saving valuable time on scheduled flights. Developed by The Parker Appliance Co., the unit comprises a hose nozzle and a tank port, both operating as a single valve to admit fuel to the tank at 200 gallons per minute flow at low pressure.

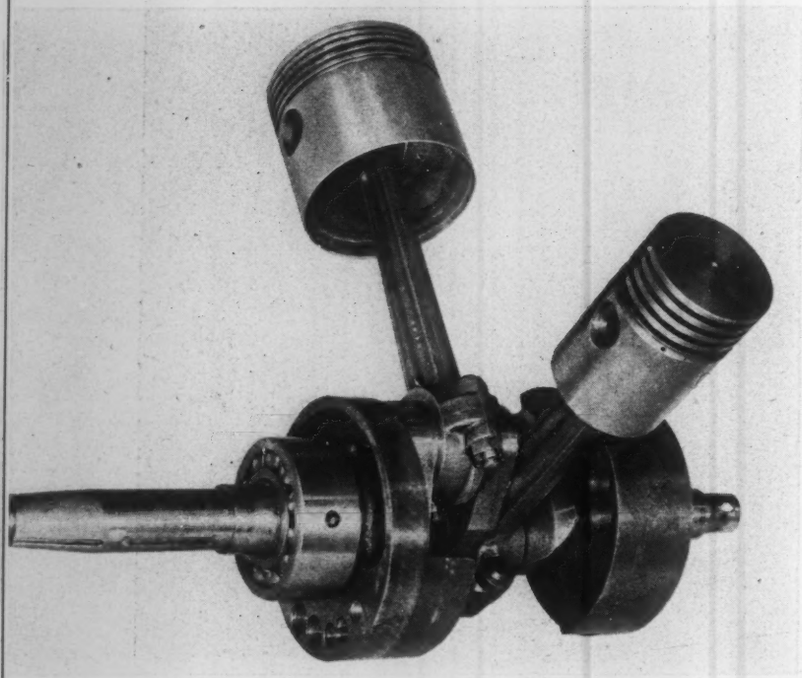
Nozzle unit has a stem-type, spring-loaded valve having a rubber ring which seals against a circular metal shoulder integral with the nozzle body. Top face of this valve mates flush with a similar opposing valve member in the tank unit. Actuating the nozzle valve opens and closes the tank valve, leaving less than a teaspoonful of free fuel in between when the units are disconnected.

Cross-sectional view of the nozzle unit is shown at right. A bayonet type coupling assembles the two units. The valve is lifted by a crank which is restrained by a cam unless the bayonet is assembled in the tank unit. Thus there is no way of opening the valve unless the two parts are connected. Also, the units cannot be separated unless the valve is closed.

Referring to the cutaway view, the nozzle valve has opened the



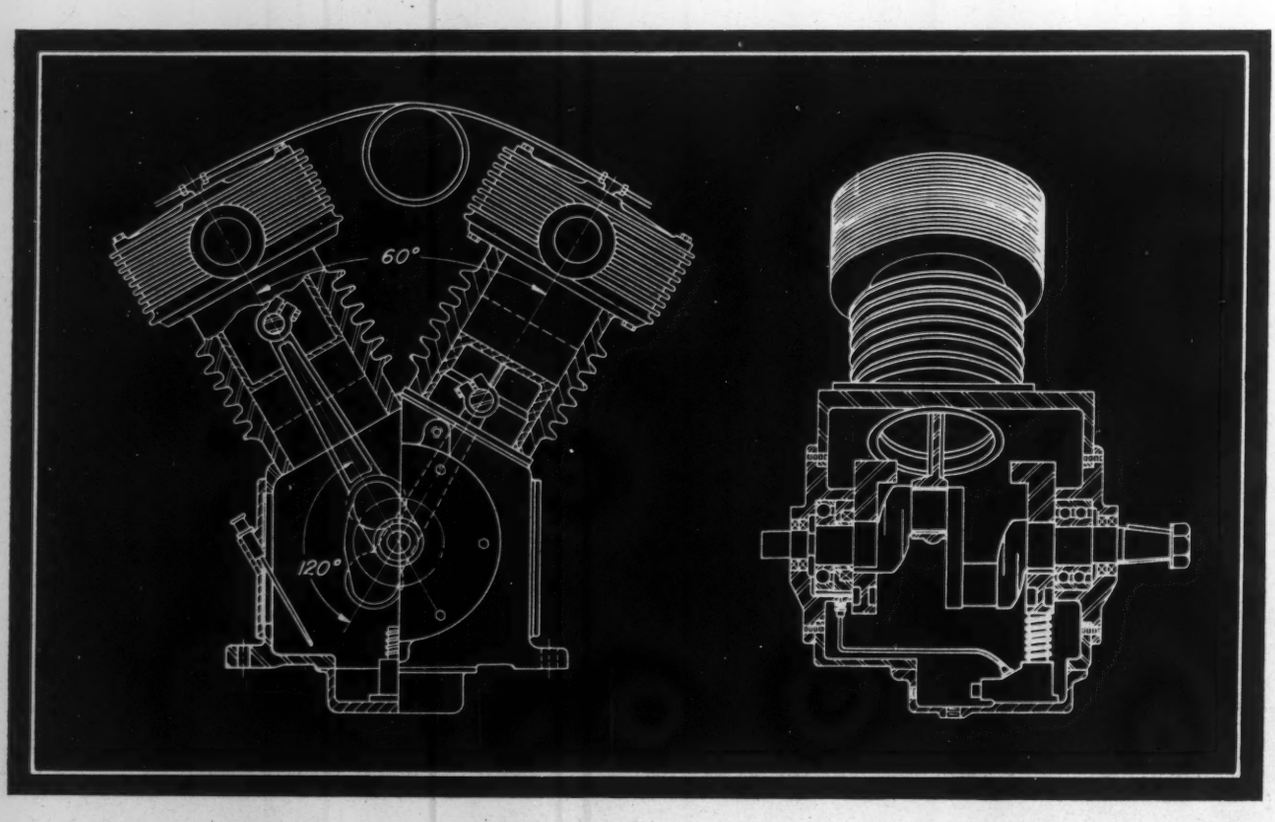
lower tank valve. Fuel flow raises the upper piston valve, permitting fuel to enter the tank. As filling progresses, fuel bleeds through a small port in the center of the piston and flows through a small line to a remote safety shut-off float valve. This fuel escapes into the tank until the float valve closes, checking the flow in the line. With pressures balanced on the piston, its spring starts closing it and the differential area between the bottom and top surfaces of the piston produces the final closing pressure, stopping the flow of fuel into the tank.



Principles of balancing, properly applied to a two-cylinder reciprocating air compressor, have resulted in the unique design shown. Invented by Paul H. Davey, Davey Compressor Co., Kent, O., and used on their 60 and 105-cfm V-type compressors, the new design is characterized by a two-throw crankshaft having the throws spaced at an angle which is the supplement of the angle of the Vee. For example, with a 60-degree Vee the cranks are spaced at 120 degrees.

Conventionally, two-cylinder compressors are either "in-line" with a two-throw 180-degree crankshaft or V-type with a single crank handling both pistons. The former gives equal spacing of the working strokes but introduces a serious rocking moment due to the wide spacing of the cylinders in the longitudinal direction. The latter is more compact and has a negligible rocking moment but produces unequal spacing of the working strokes as well as serious unbalance of reciprocating forces.

By employing a V-design with two cranks at the specified angle, the advantages of compactness and equally spaced working strokes are realized, while the rocking moment is negligible and the net unbalanced reciprocating force is greatly reduced compared with the single-crank V-type.



By David R. Pearl
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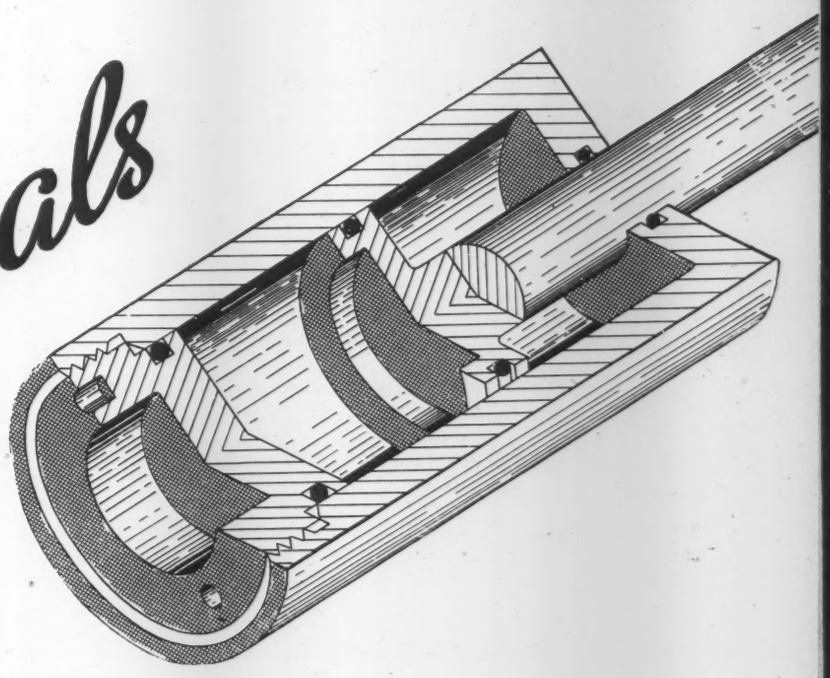
O-Ring Seals



Practical information on their design, characteristics, and application in hydraulic mechanisms is given in this timely article based on a paper presented at the annual SAE meeting

ONE of the most persistent problems in the design of hydraulic systems is the sealing of operating fluid in pumps, transmission piping, and hydraulic motors or pistons. In stationary hydraulic installations, the steady loss even of extremely small amounts of fluid from the various joints cannot be disregarded because over a period of time it may amount to expensive quantities of fluid or lubricant, while in transportation equipment, where fluid supply is limited, external seals must be perfect to prevent disastrous loss of the operating medium. Internal leakage, such as might occur past the seals on a hydraulic piston, affects the operation and efficiency of the system, while excessive leakage may prevent operation.

Criteria for an ideal hydraulic seal are as follows:

1. Absolute sealing dependability under any pressure through a wide temperature range and under any conditions of pressure application or piston motion
2. Long seal life with a gradual increase in leakage as the seal finally begins to wear out.
3. Simple and rugged construction of seal and seal supporting structure without the necessity for extremely close dimensional tolerances
4. Easy assembly or replacement of seals in the mechanism without the use of special tools or fixtures
5. Perfect sealing in both directions of pressure application with a single seal
6. Low sliding friction for a seal used on a reciprocating or rotating piston
7. Ability to seal in spite of slight surface irregularities in mating parts
8. Low cost of manufacture and maintenance of seals and seal housings.

It has been found in tests and in service experience that O-ring seals offer a reasonable approach to this ideal

Fig. 1—Below—Cross section of piston, cylinder and O-ring seal before pressure is applied to the fluid

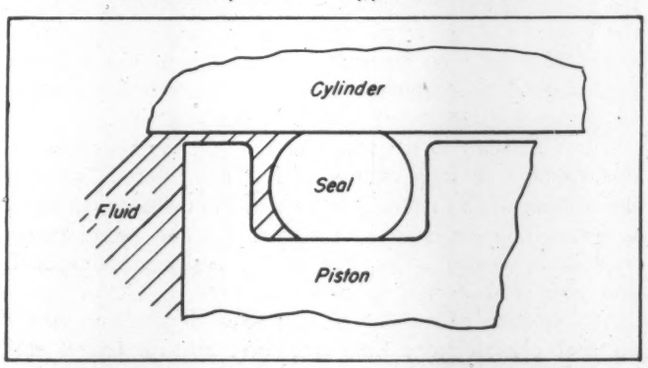
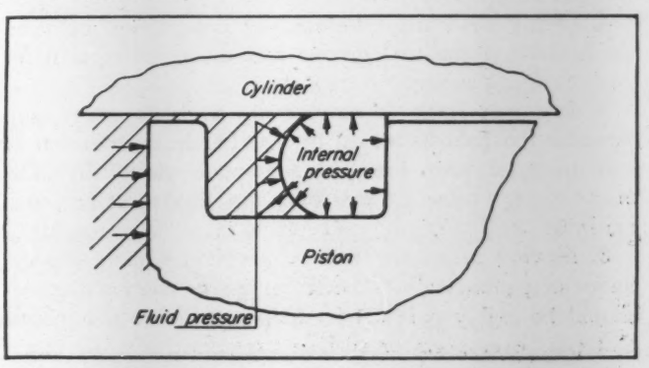


Fig. 2—Below—Action of seal under fluid pressure. Seal material, like viscous fluid, transmits pressure in all directions



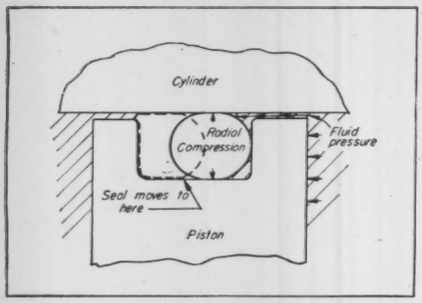


Fig. 3—Effect of reversing the direction of fluid pressure on O-ring seal

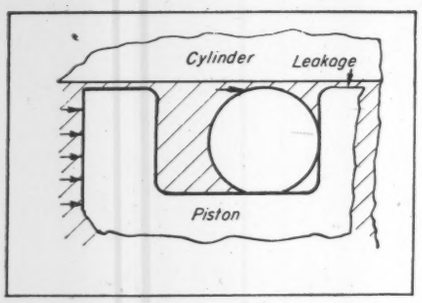


Fig. 4—When O-ring seal is not pre-compressed, fluid flows through piston-cylinder clearance, effecting no seal

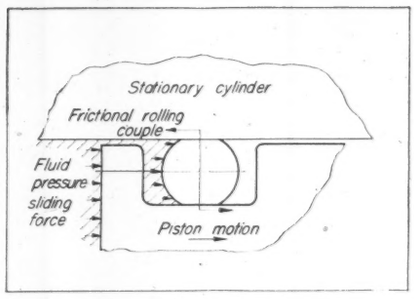


Fig. 5—Forces tending to move O-ring seal in its groove on a sliding piston

in many applications. They are listed in Army-Navy Aeronautical Specifications (AN-6227, Packing—"O" Ring Hydraulic and AN-6230, Gasket—"O" Ring Hydraulic) and manufacturers of hydraulic equipment are specifying them in ever widening fields of application, especially in aircraft hydraulics. The lead illustration of this article shows the use of O-ring seals in a typical double-acting servo piston.

Characteristics of O-Ring Seals

Hamilton Standard Propellers Division of United Aircraft Corp. has conducted a research program to investigate the sealing and wearing characteristics of synthetic rubber O-ring seals for static, reciprocating, and rotating pistons; and to accumulate design data for this type of seal with special regard to hydraulic pressures above 1500 psi. As a result, the following general characteristics of O-ring hydraulic seals have been established:

1. Seals can be made perfectly leak-proof for cases of static pistons and cylinders for fluid pressures up to 5000 psi (limit of test pressure). Pressure may be constant or variable.

2. Seals can be made to seal satisfactorily between reciprocating pistons and cylinders at any fluid pressure up to 5000 psi. There may be slight running leakage (a few drops per hundred strokes) depending on the film-forming ability of the hydraulic medium. O-rings can be used between rotating members with similar results but in all cases the surface rubbing speed must be kept low.

3. A single O-ring will seal with pressure applied alternately on one side and then on the other, but in cases of severe loading or usage under necessarily unfavorable conditions, seal life can be extended by designing the mechanism so that each seal is subjected to pressure in one direction only.

4. O-ring seals must be radially compressed between the bottom of the seal groove and the cylinder wall for proper sealing action.

5. In either static or moving O-ring seals under high pressure the primary cause of seal failure is extrusion of seal material into the piston-cylinder clearance. The major factors affecting extrusion are fluid pressure, seal hardness and strength, and piston-cylinder clearance.

6. Moving seals may fail by abrasion against the cylinder or piston walls. Therefore, the contacting surfaces should be highly polished for long seal life. Moving seals that pass over ports or surface irregularities while under hydraulic pressure are quickly cut or worn to failure.

7. Ratio of the cross-sectional diameter of the seals to the nominal piston diameter is relatively unimportant as long as the cross-sectional diameter is above a certain minimum.

8. Shape of the seal groove is unimportant as long as it results in proper compression of the seal between the bottom of the groove and the cylinder wall, and provides room for the compressed material to flow so that the seal is not solidly confined between metal surfaces.

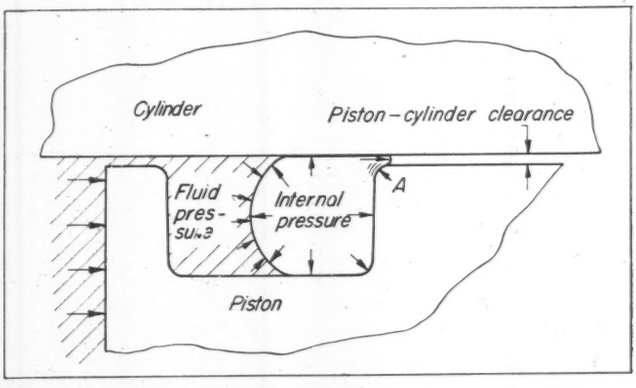


Fig. 6—Extrusion of O-ring seal into piston-cylinder clearance. Seal ruptures due to tension and shear at corner "A"

9. Sharp corners on the edges of seal grooves increase the possibility of seal extrusion, especially under pulsating pressures. Sharp corners on ports, grooves, etc., over which the seal must pass while under compression during assembly of the mechanism frequently damage the seals.

10. Width of a rectangular seal groove in relation to the width of the compressed seal is not critical as long as the groove volume is greater than the seal volume.

11. Seal may be housed in a groove in the cylinder wall instead of in the piston surface without any change in design limitations or seal performance.

12. Variations in the shape of the seal cross-section are unimportant as long as the seal is compressed between the bottom of the piston groove and the cylinder wall and is not solidly confined in the groove. The round cross-section, however, is readily made, easily standardized, and simplifies design calculations.

13. Friction of moving O-ring seals depends primarily on seal compression, fluid pressure, and projected seal

area exposed to pressure. The effects of materials, surfaces, fluids, and speeds of motion are normally of secondary importance, although these variables have not been completely investigated. Friction of O-ring seals under low pressures may exceed the friction of properly designed lip type seals, but at higher pressures friction compares favorably with, and often is less than, the friction of equivalent lip type seals.

14. Effect of temperature changes from −60 F to 250 F on the performance of O-ring seals depends upon the seal material used. Synthetic rubber can be made for continual use at high or low temperatures or for occasional short exposure to wide variations in temperature. At extremely low temperature the seals may become brittle but will still seal and will resume their normal flexibility without harm when warmed. Prolonged exposure to excessive heat causes permanent hardening and usually destroys the usefulness of the seal. The coefficient of thermal expansion of synthetic rubber usually is low enough so that temperature changes present no design difficulties.

15. Chemical action between the seal and the hydraulic medium may influence seal life favorably or unfavorably, depending upon the combination of seal material and fluid. Excessive hardening, softening, swelling, and shrinkage must be avoided.

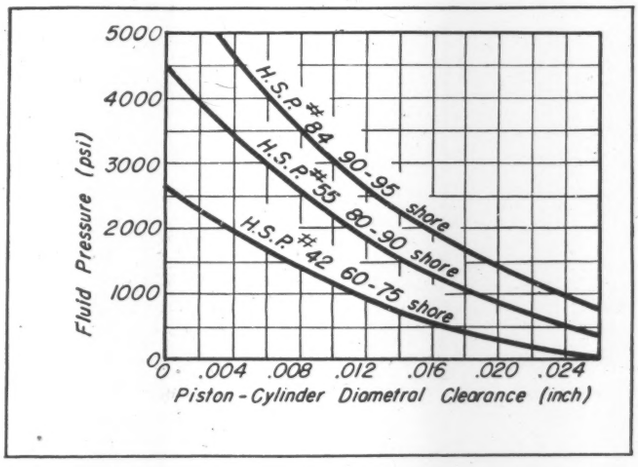


Fig. 7—Maximum piston-cylinder clearances for O-ring seals of various compositions at various fluid pressures

Fig. 8—Below—Types of seal extrusion: (a) Soft seal, (b) hard seal, and (c) double-acting hard seal

16. O-ring seals are extremely dependable because of their simplicity and ruggedness. Static seals will seal at high pressure in spite of slightly irregular sealing surface and slight cuts or chips in the seals. Even when broken or worn out the seals may offer some measure of flow restriction for emergency operation.

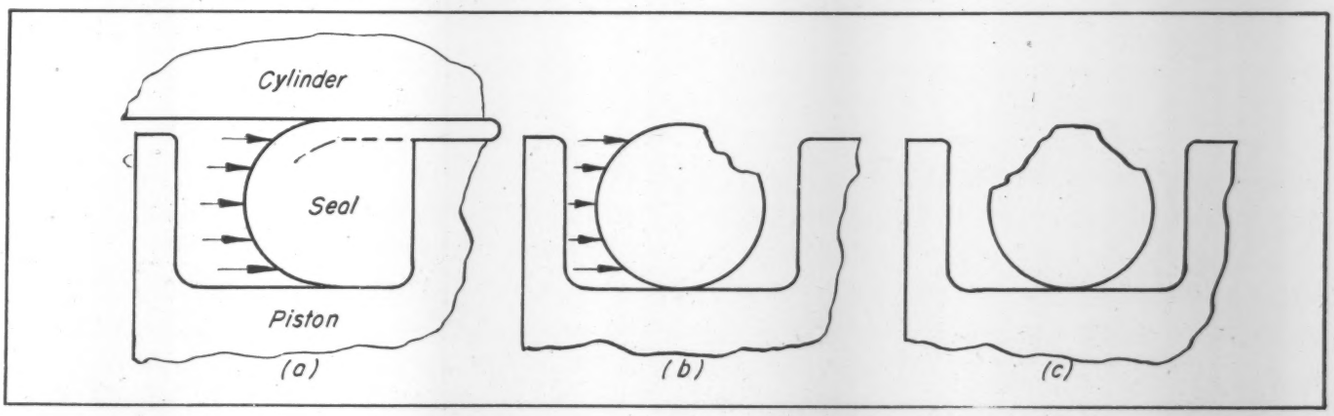
17. Cost of O-ring seals and the machining expense necessary to incorporate them into hydraulic mechanism designs are at least as low as for any other reliable type of seal.

Theoretical Aspects of Seal Operation

The theoretical aspects of the operation of O-ring seals may be discussed by considering a cross-section of a piston, cylinder and seal. Synthetic rubber under pressure acts, for all practical purposes, like a viscous fluid. It is incompressible but will deform and transmit pressures equally in all directions. *Fig.* 1 shows the conditions existing in a normal seal assembly before pressure is applied to the fluid being sealed. Considering the piston fixed with respect to the cylinder, as pressure is applied a force is exerted on the seal causing it to move, against one wall of the groove, *Fig.* 2. The fluid does not leak between the seal and the diametral surfaces of the piston and cylinder because at zero pressure the resilience of the rubber furnishes the sealing force, and under hydraulic pressure, the internal pressure imparted to the seal by the fluid maintains this sealing force.

If the direction of the fluid pressure is reversed from the left side of the seal as shown in *Fig.* 2 to the right side as in *Fig.* 3, there will still be no leakage. When the pressure on the left side drops, the seal tends to spring back to its original shape, and though the entire right side of the seal is not immediately exposed to pressure, the fluid works down along the right side of the seal because radial precompression prevents leakage above or below the seal. When sufficient force exists to overcome seal friction the seal moves to the left wall of the groove where it seals as shown by the dotted outline in *Fig.* 3

The need for precompression of O-ring seals between piston and cylinder immediately becomes evident because if there is no compression, as shown in *Fig.* 4, the fluid will merely run through the gap between rubber and metal. Because synthetic rubber is practically incompressible, the necessary seal compression must be obtained by distortion of the seal and care must be exercised in



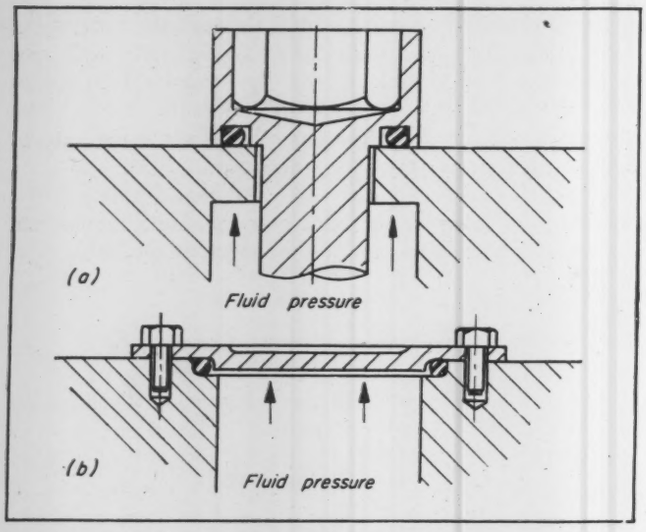
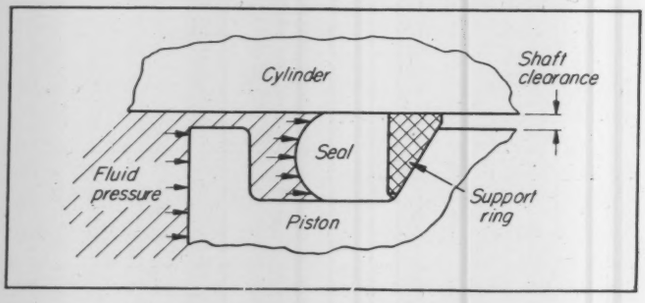


Fig. 9—Above—How O-ring seals may be used in place of flat gaskets; (a) Bolt head, (b) cover plate

Fig. 10—Below—Method of using extrusion-preventing support ring to retard O-ring seal extrusion



design to insure that the seal volume is less than the groove volume under all tolerance conditions. If not, the excess rubber will be sheared off at assembly of the mechanism. Excessive seal compression, even with ample groove width, may result in shearing and high friction.

Moving O-Ring Seals

Sliding O-ring seals which operate between reciprocating pistons and cylinders or between rotating members, seal in the same manner as stationary seals. When piston motion is reversed with direction of fluid pressure unchanged there will be no change in the position of the seal with respect to the groove walls as long as the fluid pressure force is greater than the frictional forces tending to roll the seal, *Fig.* 5. When the direction of pressure is changed with the change in direction of piston motion the seal will move over to the opposite wall of its groove.

Leakage in Moving O-Ring Seals: Unlike static O-ring seals which, if properly designed, are leak-proof at all pressures, sliding O-rings may show slight running leakage of a few drops per hundred piston strokes. Tests have shown that with high grade lubricating oil the seal may ride on an oil film instead of wiping the surface dry and this film eventually collects into drops of oil. As soon as motion stops, this leakage stops; and low-viscosity hydraulic fluids with poor film-forming tendencies may not permit leakage at all. When present, this running leakage usually is light enough to be inconsequential and it helps to reduce seal friction. Since synthetic rubber has a high coefficient of friction against most materials, O-ring seals are subject to eventual abrasion or overheating due to friction and, therefore, are not recommended for use in continuously and rapidly reciprocating parts such as engine valves and pump pistons. But where a life of 100,000 to 500,000 cycles is considered ample they normally can be used to great advantage.

Rotating Shaft Seals: For O-ring seals used on rotating shafts, practically the same design precautions are necessary as in the case of reciprocating seals. They are not recommended for continuous rotation except at low rubbing speeds. Seals above 80 Shore Durometer hardness have less tendency to stretch or bunch during rotation than do softer seals.

Friction of O-Ring Seals: Friction of moving O-ring seals depends primarily upon seal hardness, seal compression, fluid pressure, and size of seal. Experience has indicated that seal friction in specific installations is also affected by seal and cylinder materials, type of surface, degree of lubrication and speed of motion but there is need for far more extensive research before definite statements can be made concerning these variables. Since even the closest production tolerances permit a wide variation in friction, caution should be exercised when incorporating O-ring seals into mechanisms where extremely low friction is necessary. Under increasing fluid pressure, the precompression friction, though still present, usually is overshadowed by hydraulic friction.

Principal cause of failure of high-pressure O-ring seals is extrusion of the seal material through the gap formed by clearance between piston and cylinder. Being in ef-

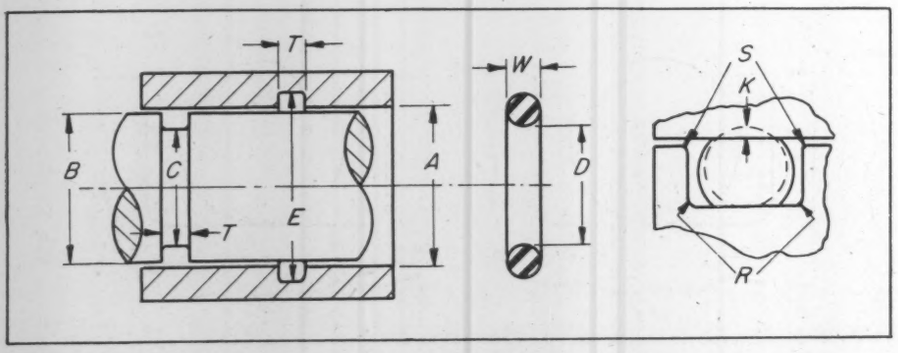


Fig. 11—Left—Element designations used in formulas recommended for O-ring seal design

fect plastic, the rubber tends to extrude into this space under pressure as shown by *Fig.* 6. Tests have shown that resistance to extrusion varies directly with seal hardness, inversely with piston-cylinder clearance, and inversely with fluid pressure. *Fig.* 7 shows the maximum recommended diametral piston-cylinder clearance for variations in seal hardness at various fluid pressures. It has been found that rapid pressure surges result in impact loads which tend to accelerate extrusion. The curve values of *Fig.* 7 are based on a seal life of 100,000 cycles from zero to the indicated pressure at the rate of 150 surges per minute. Lower pressures or rates of application will give longer seal life.

When a seal begins to fail by extrusion it rotates slightly to cover the gap with new material. This extrusion continues until finally the seal unrolls into the piston-cylinder clearance as shown in *Fig.* 8*a*. This extrusion in a sheet occurs only with softer seals. Harder seals tend to chip off leaving the seal looking like *Fig.* 8*b*. A double-acting seal subject to extrusion fails as shown in *Fig.* 8*c* and it can be seen that failure to the point of leakage is more rapid in this case.

Special Uses for O-Ring Seals

In addition to normal use between cylindrical surfaces, O-ring seals may be adapted to the solution of special sealing problems. Flat surface gaskets such as might be required under cylinder heads or bolt heads may be replaced by O-ring seals, as shown in *Fig.* 9, for dependable sealing at high pressures. This construction may be used to advantage in sealing bolt heads where bolt shank tolerances are excessive, *Fig.* 9*a*. Also, where the variable thickness of a flat gasket might affect the function of a mechanism, an O-ring can be used and still permit metal-to-metal contact between mating parts. An oval or irregular groove path will work as well as an ordinary circular groove, *Fig.* 9*b*.

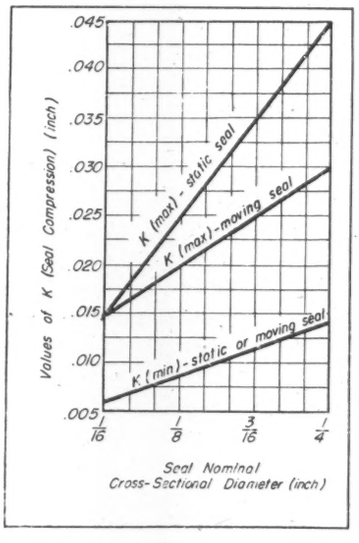


Fig. 12—Left—Recommended radial seal compression for various O-ring seal cross-sectional diameters (values of K for use in dimensional formulas)

Noncircular shaft sections such as elliptical, round-cornered rectangular, etc., may be sealed with standard O-rings using normal design procedure as long as the seal is precompressed between its groove bottom and the sealing wall at all points and the clearances do not permit extrusion. Sharp-cornered cross-sections also can be sealed if the O-rings are molded with corresponding sharp corners.

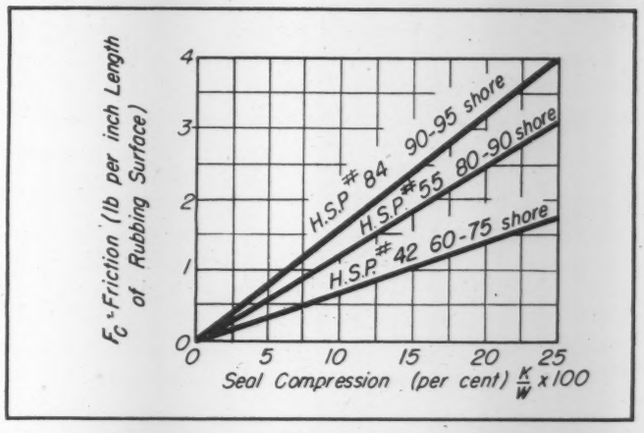


Fig. 13—Curve for estimating O-ring seal friction due to seal compression with various seal materials

EXTRUSION-PREVENTION RINGS: Where excessively high pressures or large piston-cylinder clearances cannot be avoided, O-ring seals can be used if extrusion-preventing rings are included in the installation. These consist essentially of thin metal rings split like piston rings so that they fit themselves against the cylinder wall under pressure and thereby eliminate the extrusion gap as shown in *Fig.* 10. Where the seal groove is in the cylinder, leather or fabric support rings may be installed by folding, and have been found to increase O-ring seal life materially. Some of these devices are now commercially available, while others are still in the development stage.

Design Procedure

O-ring seals cannot be considered mere rubber bands to be dimensioned in fractions of an inch. The design of O-rings and their seal grooves should be as careful a process as the design of any other precision part. The following design procedure is recommended:

1. Selection of materials and piston-cylinder clearance
2. Determination of seal sizes and groove dimensions
3. Estimation of friction of sliding seals
4. Verification of design details.

SELECTION OF MATERIALS AND PISTON-CYLINDER CLEARANCE: The hardness of the seal material should be selected from *Fig.* 7, using pressure and piston-cylinder clearance as independent variables. If in the seal application, the piston is supported externally so that it is concentric with the cylinder bore, the clearances shown by *Fig.* 7 may be considered maximum radial clearances, but if the piston is supported by the cylinder wall, these must be used as diametral clearances.

Selection of piston and cylinder materials generally is independent of seal material selection. As long as there is no adverse chemical action, excess deformation, porosity, or surface roughness, practically any of the standard engineering materials may be used with or with-

out the ordinary protective platings.

DETERMINATION OF SEAL SIZES AND GROOVE DIMENSIONS: It will be assumed that all seals will be of circular cross section and all grooves will be flat bottomed. Where unusual design limitations make other shapes necessary, the general principles as outlined in the following may be applied.

It is recommended that seal sizes be selected from standard seal tables; specifications AN-6230—gaskets, and AN-6227—packings; which list O-ring seals by actual diameters and dimensional tolerances. It is emphasized, however, that specifying an AN standard seal automatically specifies the seal material as AN-HH-P114 Class B, which is similar to HSP-42 material and is unsuitable for use above 1500 psi in most cases. Where other seal material is necessary, it must be so specified in addition to the AN seal number. The seal proportions listed in the table "Recommended O-Ring Seal Proportions" are useful where AN standard seal proportions cannot be adhered to.

The effect of piston-cylinder clearances and concentricity tolerances should be considered in choosing seal

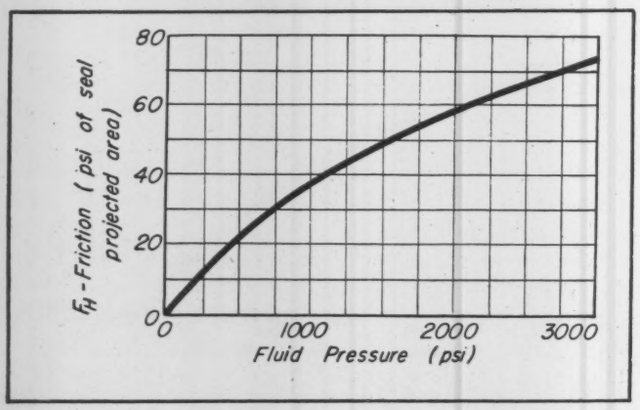
Recommended O-Ring Seal Proportions

Piston Outside Diameter (inches)	Nominal Cross-Sectional Diameter (W_n) (inches)	Actual Cross-Sectional Diameter (W) (inches)
Below ½	1/16	0.070 ± 0.003
½ to below ⅞	3/32	0.103 ± 0.003
⅞ to below 4	⅛	0.139 ± 0.004
4 to below 7	3/16	0.210 ± 0.005
7 to 12	¼	0.275 ± 0.006

and groove sizes to insure that in the worst case of tolerance build-up and eccentricity, the seal is still precompressed at all points. Larger seal cross-sections with high seal compression often may be used to good advantage in such a situation but under the penalty of increased friction.

Seal compression and diameter of seal groove are interdependent because of the dimensional tolerances on each part. The following formulas, in conjunction with *Fig.* 11, may be used to determine the maximum and minimum dimensions of all members involved and to find seal diameters when AN standard seals cannot be used. The dimensional limits determined by these formulas may be varied a few thousandths of an inch in special cases at the discretion of the designer, but such seals should be subjected to test before acceptance.

Fig. 14—Curve used for estimating O-ring seal friction which is due to the hydraulic pressure applied



For Seal Groove in Piston:

$$C_{max} = A_{min} - 2\,(W_{max} - K_{max}) \quad \ldots\ldots (1)$$
$$C_{min} = A_{max} - 2\,(W_{min} - K_{min}) \quad \ldots\ldots (2)$$
$$D_{max} = C_{min} - 0.10\,(W_n) \quad \ldots\ldots (3)$$
$$D_{min} = C_{min} - 0.25\,(W_n) \quad \ldots\ldots (4)$$

For Seal Groove in Cylinder:

$$E_{min} = B_{max} + 2\,(W_{max} - K_{max}) \quad \ldots\ldots (5)$$
$$E_{max} = B_{min} + 2\,(W_{min} - K_{min}) \quad \ldots\ldots (6)$$
$$D_{max} = B_{min} - 0.10\,(W_n) \quad \ldots\ldots (7)$$
$$D_{min} = B_{min} - 0.25\,(W_n) \quad \ldots\ldots (8)$$

For All Seals:

$$T_{max} = 1.30\,(W_{max}) \quad \ldots\ldots (9)$$
$$T_{min} = 1.25\,(W_{max}) \quad \ldots\ldots (10)$$
$$R = 0.020 \text{ to } 0.030\text{-in. radius} \quad \ldots\ldots (11)$$
$$S = 0.005 \text{ to } 0.010\text{-in. radius} \quad \ldots\ldots (12)$$

Where:

A = Inside diameter of cylinder
B = Outside diameter of piston
C = Outside diameter of seal groove in piston
D = Inside diameter of seal (AN-6227, AN-6230 or compute as shown above)
E = Inside diameter of seal groove in cylinder
R = Radii in bottom of seal groove
S = Radii on corners of seal groove
T = Width of seal groove
W_n = Nominal fractional seal cross-sectional diameter (AN-6227, AN-6230, see table)
W = Actual seal cross-sectional diameter (AN-6227, AN-6230, or see accompanying table)
K = Radial compression of seal (*Fig.* 12)

ESTIMATION OF FRICTION OF SLIDING SEALS: Because of the many factors that may influence O-ring seal friction, it is impossible to predict it exactly. However, by use of the curves in *Figs.* 13, 14, and the following formula, a reasonable estimate of seal friction may be made:

$$F = F_c + F_h$$

where F is total seal friction in pounds. F_c is friction due to seal compression which is obtained from *Fig.* 13. To use this curve the nominal seal compression is expressed in per cent of actual seal cross-sectional diameter and the curve value must be multiplied by the length of seal-rubbing surface in inches. F_h is friction due to hydraulic pressure on the seal and is obtained from *Fig.* 14. The curve values must be multiplied by the projected area of the seal exposed to pressure with the seal in its groove. Area $= \pi/4\ (A^2 - C^2)$ for a seal groove in the piston and $\pi/4\ (E^2 - B^2)$ for a seal groove in the cylinder.

VERIFICATION OF DESIGN DETAILS: The completed design should be reviewed to see that seals do not pass over ports or corners under pressure, that they are not forced over sharp edges in assembly, that rubbing surfaces are smooth, that seal grooves have proper radii in corners and on edges, and that seals are not pinched in assembly.

Piston and cylinder designs should be checked to insure that under maximum pressure or load, deformations that can increase the sealing gap appreciably do not occur, as this is a frequent cause of failure of otherwise well designed seals. The designer should be particularly careful about this where there are large seal diameters and the parts are made of aluminum, bronze, or other low-modulus-of-elasticity materials.

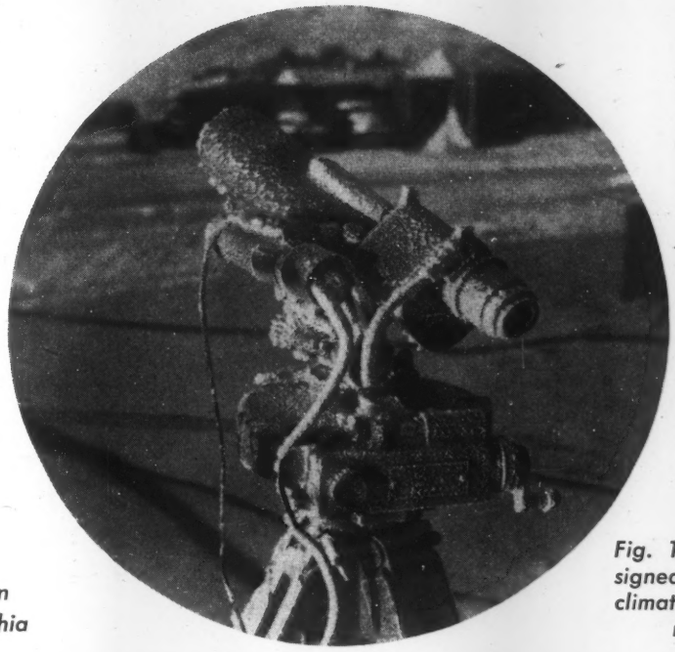


Fig. 1—Observation telescope designed for operation in temperate climate is covered by heavy frost, rendering it inoperative

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Designing For Extreme Cold

A discussion of design techniques based on tests performed by the author in the Canadian Arctic

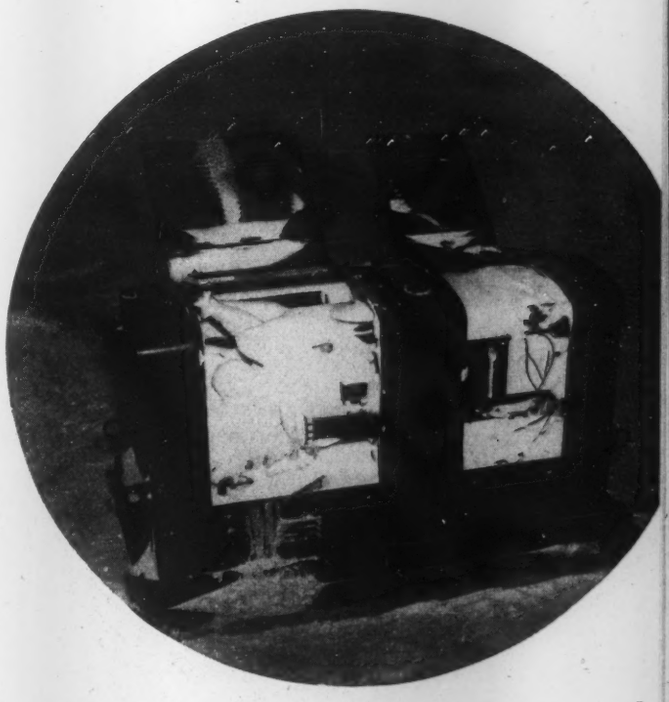


Fig. 2—Snow will blow into even the smallest opening. This generating unit was clogged with snow blown in through the ventilating louvres

PROPER operation of any equipment in extreme cold starts at the drawing board. A slight amount of foresight and adherence to established principles of physics and engineering, and an understanding of the operator's duties will not add materially to the cost of engineering or production, but can save endless hours of field trouble.

Basic design principles for withstanding cold are well known to many engineers, but it is surprising how seldom the principles are applied. This is usually because of the fact that the equipment is not designed primarily for such use, *Fig.* 1, and conventional practices are perfectly satisfactory for temperate use. In order to assist the engineer faced with the problem of "arctic" designing a number of general features can be set forth.

MATERIALS: Everyone knows that different materials have different temperature coefficients of expansion, but no one does very much about it. It is common to find motors with steel shafts and aluminum housings, or mechanisms consisting of steel shafts and brass gears assembled on an aluminum base plate. These practices are perfectly satisfactory if provision is made for adjusting end play and if the gear meshes are so set up that they will have a slight amount of backlash at −45F. In most cases the additional backlash at room temperature can be tolerated.

Rubber and synthetic rubber become quite brittle at low temperatures. This can cause cracking of electrical insulation, particularly where vibration is present. There are several commercially available insulated wires which are perfectly satisfactory down to −45F. They cost about the same as wire which will not withstand this temperature and are just as easy to use. The main difficulty seems to be to get

design engineers to call for them on drawings.

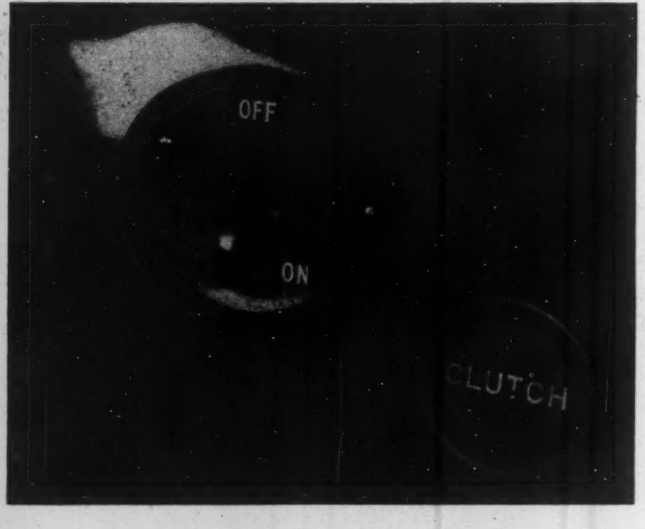
The large variety of available lubricants and the special functions of many of these is likely to cause considerable confusion. There are in existence many suitable low-temperature greases and oils but the mere use of these materials will not guarantee performance. All lubricants should be used sparingly if satisfactory low-temperature operation is to be achieved. For normal temperature operation it is safer to err on the side of overlubrication, but for use in cold the opposite is true.

Electrical and Electronic Equipment: Electrical equipment such as motors, generators, wire, cable and synchros is used extensively out of doors. While this equipment is operating it usually comes into temperature equilibrium approximately 100F above the surrounding temperature. Operation, therefore, presents little difficulty if the equipment can be started. Specific difficulties usually found with motors are: Insufficient end play, over lubrication, insufficient clearance in sleeve bearings, open-frame design, and built-in worm or gear reductions. The proper amount of end play (measured at room temperature) depends on the materials used for the frame and rotor. If the frame material has a higher temperature coefficient of expansion than the rotor material, it will pinch the rotor between the bearings, effectively preventing starting. Some motors are so designed that end play can be adjusted by means of a thrust screw at one end of the frame or by removing bearing shims. Others will require the actual removal of metal from the rotor or housing.

Electric Motors Require Careful Design

As a result of these difficulties, some manufacturers are now building motors in which the front (shaft end) ball bearing is locked both on the shaft and in the front end cap. The rear bearing is a light press fit on the shaft, thereby allowing the shaft to contract differentially with respect to the frame and thus eliminate pinching. This type of construction yields no end play at any temperature, thus assuring satisfactory bevel-gear fits. The design would fail if corrosion occurred where the shaft goes through the rear bearing, but this same type of failure is possible with conventional end-play designs.

Fig. 3—Toggle switch correctly sealed with close-fitting rubber sleeve does not admit snow to interior of machine



Motor bearings require lubrication, but not much. Ball bearings packed full of grease can add considerably to motor starting difficulties. Grease in accordance with U. S. Army Specification AXS-637 has been found suitable for lubrication to −45F, if properly applied. In many instances motors could be made operative by merely cleaning out the grease and relubricating with a thin layer of the same grease. Although this may sound like a small point, actually it is one of the major causes of extreme-cold difficulties. Sleeve bearings, in general, are unsatisfactory for use in extreme cold. Since they are necessarily of different material than the shaft, proper clearance at room temperature will result in seizure at −45F. If it is not possible to avoid their use, they should be opened up to allow a free-running shaft fit at the lowest temperature to be encountered.

Snow Penetrates Smallest Opening

If motors are to be used unprotected under winter conditions, then special consideration should be given to the type and frame design. More often than not, a condition known as ground haze will be found to exist at very low temperatures. This consists of extremely fine particles of snow blown about by the wind. Usually this haze remains within one or two feet of the ground, but it can rise as high as 50 or 60 feet, depending on the wind velocity. As a direct result, fine particles of snow are blown into even the smallest opening in a piece of equipment. Such snow fouling is shown in *Fig.* 2. Toggle switches, *Figs.* 3 and 4 and circuit breakers are particularly affected by this condition. Motors also require protection. The snow itself does not affect operation, but some of the snow will melt, and during shutdown this melted snow will freeze, covering the equipment with a coat of ice. Nothing less energetic than a blowtorch will get it started again if this happens. Even motors built into a larger piece of equipment and therefore "protected" will sometimes succumb to this trouble if precautions are not taken.

The toughest sort of winter service is that which requires both indoor and outdoor use. Indoor atmospheres are, of course, heated, and have a considerably higher moisture content than outdoors. Consequently, moisture will condense all over a piece of equipment which is brought into a warm room. This, in addition to being a major source of corrosion requires that the equipment be thoroughy dried before being taken outdoors again, otherwise it will freeze solid.

Polyphase motors, which do not require special built-in starting gadgets, will provide the most trouble-free operation in the cold, and should be used wherever possible. Worm or gear-reduction boxes cause trouble because they are packed full of grease, *Fig.* 6, and because they usually have sleeve bearings even though the motor itself is equipped with ball bearings. Both of these difficulties have been discussed already. Constant-speed motors, which depend on centrifugally-operated electrical contacts to maintain speed, should be used with caution if close speed control is required. Several such motors tested by the author started to run slow at −20F, and ran as much as 4 per cent slow at −30F. However, a mechanical gov-

ernor coupled to the motor shaft maintained speed to within 0.2 per cent down to −45F.

There is no excuse for cracked insulation on lead wire to motors or on general hookup wire. As already mentioned, many insulations are suitable for use down to −45F. These will permit a wire to bend around its own diameter even at this low temperature. If such wires are used, vibration of the equipment during operation or transportation will not cause cracked insulation. Repairs and adjustments are greatly simplified if the repairman does not have to worry about damaging wires by moving them. Jacketed multiconductor cable, employed to interconnect pieces of equipment, present a different problem. In this case, natural rubber and neoprene (GRN) are desirable jacket materials because of their high abrasion and tear resistance. However, these materials become brittle at low temperatures. Neoprene is usable down to approximately −20F and natural rubber to about −40F, but in any case it is advisable to protect the cable from rough mechanical abuse.

Synchros and similar low-torque electrical devices do not seem to give as much trouble as ordinary motors. This is undoubtedly due to the fact that most synchros are designed primarily for military use, where operation at both extremes of temperature is a must. Synchro ball bearings, lightly lubricated with oil in accordance with U. S. Army Spec. 2-27E, have proved perfectly satisfactory. This same oil can be used in other cases where even a light application of grease creates excessive torque loss.

Gasoline Engines a Particular Problem

Gasoline engine-driven generating equipment causes many special headaches. The generators suffer from the same design difficulties mentioned in the discussion of motors. Although these difficulties can make life miserable for the operating personnel, they do not present insuperable design problems. The faults can be "designed out" of any particular piece of equipment without increasing cost, and manufacturers should not hesitate to adopt new designs or modify existing ones to achieve satisfactory cold operation. In the field of gasoline engines, however, we are up against a white horse of a different color. No major redesign of any but small two-cycle engines seems economically possible, and without special starting aids, most commercially-available gasoline engines cannot be started below −20F. Even with these aids, starting can be very difficult unless certain precautions are observed.

A small amount of water in oil used in a crankcase of an engine will hasten the formation of a sludge that may deposit in oil lines, clog filters, and deposit on pistons and cylinders. This may result in burned-out bearings or in an inoperative engine. A larger amount of water may separate and freeze in the oil sump or even in the oil pump itself so that no oil can be pumped to the moving parts when the engine is started.

Storage and handling of engine fuels and lubricants is of extreme importance. If moisture gets into the gasoline, it will prove quite bothersome. Moisture not only can, but does get in as a result of snow being blown into containers during filling, condensation due to breathing of a partly filled container, condensation from warm air in a partly-filled container when brought outdoors from a warm storage place and even, it seems, because a special Arctic

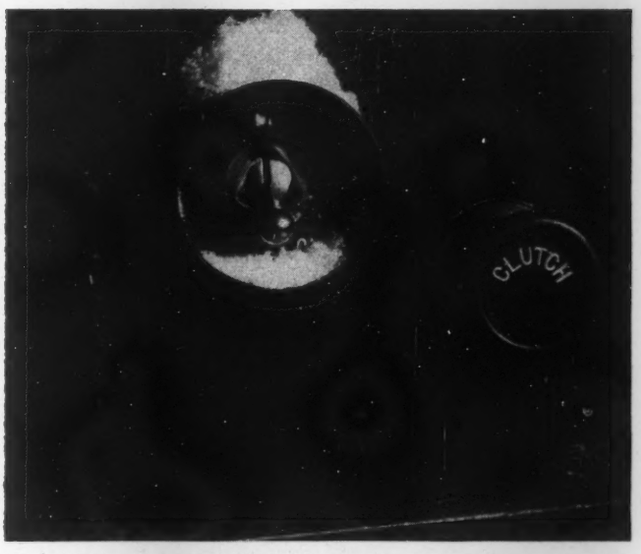


Fig. 4—Toggle switch admits snow through crack around lever. Even with close fitting cap, not shown, windblown snow caused the condition shown in Fig. 5

gremlin puts it there despite all possible operator care to avoid contamination during various handling operations.

Water in motor fuel causes difficulties. Trouble will be encountered in some engines, even at temperatures above the freezing point of water. When motor fuel is forced through carburetor jets, the pressure is released and the motor fuel sprayed or vaporized by the venturi action. This reduction of pressure in the venturi is a refrigerating action and the temperature of the water may be sufficiently lowered that it will freeze out of the motor fuel spray and collect around the jet. The ice will build up until the mixture supply is cut off and the engine stops operating.

Ice will also form on the throttle-box bearings causing the governor to lose control of the engine speed. Larger amounts of water will settle to the bottom of fuel tanks and into the lowest parts of fuel lines where it freezes so that fuel cannot reach the carburetor and the engine cannot be started.

The engine itself should be equipped with a readily-removable gasoline filter which can be removed and cleaned before and after each time the unit is operated. A drain cock at the bottom of the gasoline tank will also be of great assistance in helping to remove water from the gasoline. For operation below −10F the addition of one quart of gasoline to each four quarts of SAE-10 oil will be of assistance in providing easy starting.

Storage batteries should be kept fully charged and, if possible, heated. In many cases provision can be made to keep some "slave" batteries indoors. These can be taken out and connected in parallel with the regular battery to assist in starting. Reference to a table of battery freezing points will show why it is important to keep a battery fully charged. A battery will deliver less current at low temperatures. For example, current delivered at +15F will only be 50 per cent while the amount delivered at −30F will be only a little over a tenth of that which would be produced at room temperature. This is assuming, of course, that the electrolyte in the battery has a high enough gravity reading to prevent it from freezing under

the particular conditions which are here concerned.

In an emergency, the most satisfactory way to warm the engine is to drain the coolant, heat it to about 200F, and then put the warm coolant back in the engine. While this is being done the battery should be removed and warmed, or a freshly-charged warm battery substituted. After a few minutes of standing, the hot coolant will warm up the cylinder block and the cylinder walls so that the starting torque will be much lower; the engine will turn over faster and less power will be needed from the battery. Heating the coolant is more satisfactory than heating the crankcase oil as an aid in starting, because it is not the oil in the crankcase that hinders the start so much as the cold, thick oil on the cylinder walls.

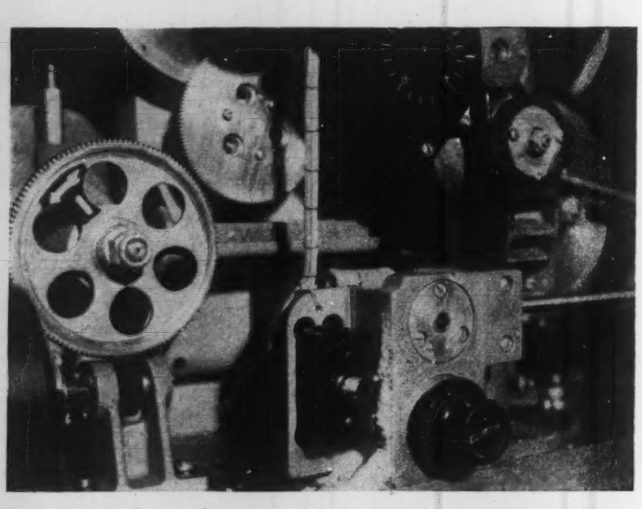


Fig. 5—Machine of Fig. 4 with cover plate removed. Snow accumulating around clutch mechanism caused ultimate jamming by forming ice on moving parts

Several methods have been developed for applying standby heat to an engine. Placing a gasoline or kerosene burner in the vicinity of the engine to provide such heat is quite inefficient, although used. A more efficient use of fuel is achieved if the burner is employed to heat a copper coil through which the engine coolant is circulated by convection. This device, known as the thermosyphon heater, has the advantage of permitting warm water to be bypassed to a battery heater. Both of these methods suffer from the defect that the combustion gases must be exhausted through a stack which soon becomes clogged with soot and ice. If the stack is not cleaned frequently, the flame will go out, rendering the heater inoperative. A third method, known as cycling, consists of operating an automatic starting relay by means of a thermocouple placed in the coolant. Whenever the coolant temperature drops below a predetermined value (20F) the relay is energized, starting the engine. The engine runs until the coolant temperature rises to another predetermined value (160-180F) at which time the engine stops.

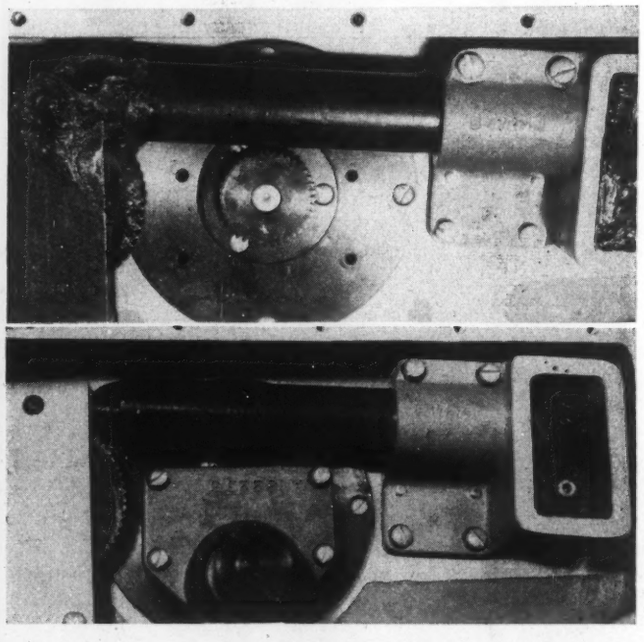
Both the thermosyphon and the cycling methods have been used successfully in the Arctic. Both methods have been sworn at and sworn by. Neither method will eliminate the necessity for frequent inspection and attention on the part of operating personnel.

If equipment is to be moved frequently, care must be taken to see that it does not freeze to the ground. Areas of contact with the ground should be given a thick coat of grease in order to prevent freezing to the ground.

MECHANICAL INSTRUMENTS: Mechanical instruments, if properly designed and assembled should give no trouble in extreme cold. Temperature coefficients of the materials used must be taken into account in setting clearances and backlash to insure that there will be no binding. Open gearing must be avoided, since hard-packed snow will be blown into the gear teeth where it will freeze. Level vials filled with ether-alcohol mixtures will become useless due to excessive contraction of the liquid and consequent increase in bubble size. Butyl-carbitol vials are quite satisfactory. Knobs and handwheels should be designed with some thought of the operator in mind. He will probably be wearing at least two pairs of gloves or mitts at −45F, so he should be given a handwheel or knob that he can use under those conditions. In general, knobs are used for those motions which require only a small rotation, say a few degrees. Knobs smaller than 1 inch or larger than 3 inches in diameter should be avoided. In addition, clearance of at least 1½ inches around and beneath the knob should be provided. Handwheels used for large rotations (several revolutions) should range from 2 to 7½-inches diameter. The same clearance should be provided as for knobs. Wherever possible, knobs and handwheels should be made of suitable plastic or other material having low thermal conductivity. This is particularly important if the instruments are to be used for a few hours at a stretch. Metal handwheels conduct heat from the hands—even through two pairs of mitts—at a rapid rate, and in the event that it becomes necessary to touch a metal handwheel with bare hands the danger of freezing to the handwheel exists.

All of the points mentioned in the foregoing are design problems which can be taken care of easily while the instrument is still on the drawing board. It will be found somewhat more difficult to take care of these points after the instruments have been built.

Fig. 6—Correct and incorrect methods of lubricating gearing. Heavily-lubricated machine will stall at low temperatures, lightly-lubricated gears will give good performance



Applying Hydraulic Accumulators

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Part II—Systems and Positioning

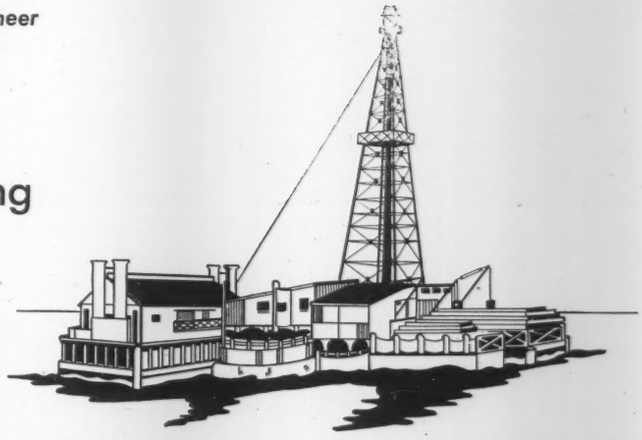


Fig. 8—One method of employing accumulators is for absorption of shock or surge, the high-pressure pumping circuit of oil well drilling rigs being readily protected against serious line failures by this means

AS INDICATED in PART I of this article, published in the April issue, accumulators often make it possible to develop greatly simplified hydraulic systems which achieve high efficiency with lower initial and maintenance costs than those normally encountered in conventional circuits. Referring once again to the seven general categories of application mentioned in the previous article, each method of ultilizing accumulators, *Fig.* 8, will be discussed to familiarize the designer with the details incident to obtaining maximum value and economy.

AS A LEAKAGE COMPENSATOR: Use of the accumulator as a compensator in connection with a pressure regulator or unloading valve has found wide application, *Fig.* 9. A pressure regulator or unloading valve is normally used in systems where the pump operates continuously. This valve serves two distinct functions: (1) to maintain the required pressure in the system within a set pressure range; and (2) to by-pass the fluid delivered from the pump at minimum pressure loss, circulating it back to the reservoir. When the pressure in the system attains the upper limit of the pressure range for which the regulator is set, the valve opens wide and the fluid from the pump is circulated freely through the valve back to the reservoir, allowing the pump to run free without building up pressure. At the same time, a check valve within the regulator prevents backflow or loss of pressure in the system above the valve. When, because of system operation or leakages, the pressure drops to the lower setting of the valve, generally 10 to 20 per cent of the unloading setting, the by-pass closes and the flow from the pump is again directed into the system.

Use of an accumulator in such circuits will assure quiet, shockless operation and, in addition, will greatly reduce the duty cycle of the regulator and increase service life. The accumulator operates to maintain a uniform system pressure and thus holds the by-pass valve in a fully open position for long periods of time. The size of the accumulator determines the time interval between the loading and unloading cycles. In many systems, especially in aircraft, it is desirable to insure a time interval from fifteen minutes to half an hour in order to obtain optimum operational characteristics. Pressure loss in such systems due to internal valve leakage or system leakage often would,

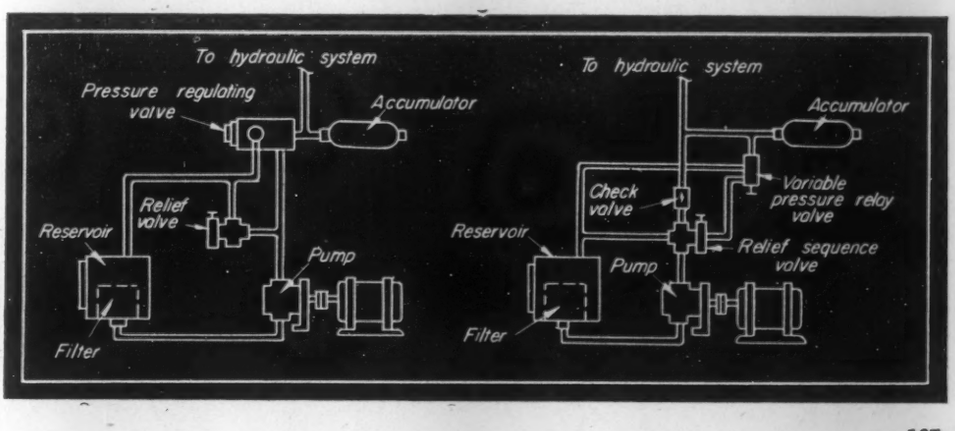


Fig. 9—Right—Diagrams showing installation of accumulator in pressure-regulator circuit. Duty cycle on regulator is greatly reduced and system operation is more satisfactory and uniform

without an accumulator, result in erratic operation, valve chatter or failure to unload altogether.

In a closed system where pressure must be held against the work by a holding ram for long periods while further duties in the operating cycle call for pump capacity, use of an accumulator in the holding circuit is of advantage. In this case, use of an accumulator in a blocked circuit eliminates the problems of holding-pressure variations created by the varying demands of branch circuits on the pump in open-circuit systems. Also, system leakages which are normally present or which develop over a period of time are automatically taken care of. An example of this type circuit, *Fig.* 10, shows an actuator working against an elastic load which must be held for a period of time at a constant pressure. Pressure is fed to the actuator ram by a selector valve which is self-centering. To meet further volumetric requirements of the machine cycle, the pump feeds other branch circuits during the holding cycle. External or internal leakage, however small, would result in piston creep, removing or varying the load on the work. An accumulator of sufficient capacity will compensate for any such leakage and maintain the correct loading over the period of time required.

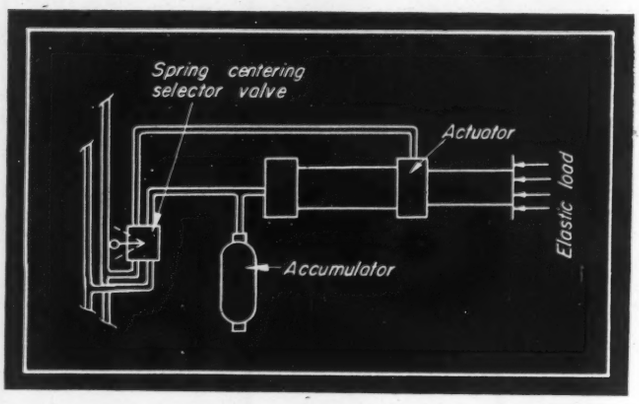


Fig. 10—Diagram showing accumulator as a leakage compensator in a holding circuit where pump capacity is fed to branch circuits during the holding cycle

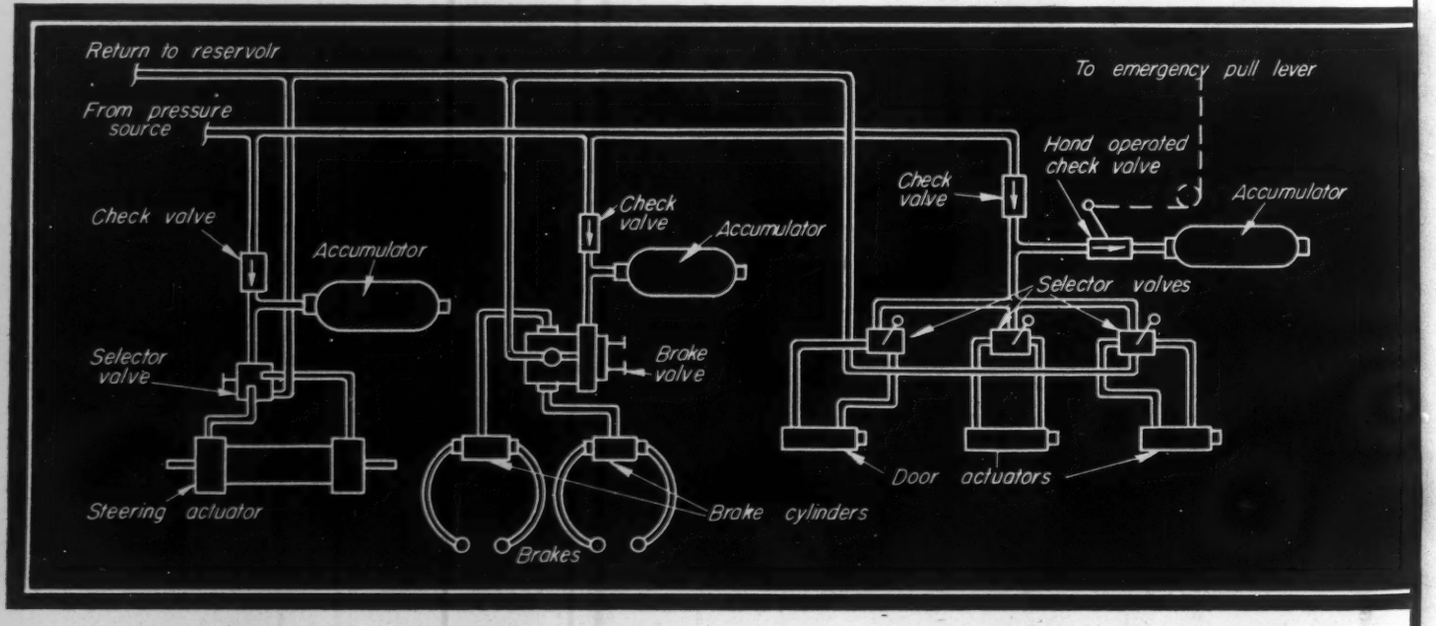
Makes Time-Holding Practical

A more pronounced example can be found in power brake circuits such as used in aircraft, rail cars, trucks, busses, and in many heavy duty industrial brake applications, *Fig.* 11. It can be seen readily that a loss in holding power of the brakes could easily cause disaster. Sources for leakage, both internal and external, on a time-holding basis are manifold. An accumulator used in the brake cylinder line as illustrated has made the use of hydraulic power brakes and parking brakes practical. An additional advantage is obtained in automatic compensation of volumetric variations caused by thermal contraction and expansion, a point which will be covered in further discussion.

As a Surge Chamber or Shock Absorber: The cushioning effect of the air charge in a pneumatic type accumulator makes it an ideal shock absorber or surge chamber. Effect of air compression irons out surges, eliminates destructive "water hammer" and line shocks and vibrations. In the unloading valve circuit described previously, the sudden opening and closing of the by-pass valve often causes hammer without the cushioning effect of the pneumatic air charge.

An interesting installation of accumulators to multiple-piston pumps has been recently made in an oil well drilling rig where the pumps are used to provide a large volume of grit and water emulsion under high pressure to the drill bit, *Fig.* 8. The fluid is pumped through a 4-inch hose to the top of the derrick where it enters the rotary drill pipe. Before accumulators were installed, the whole derrick and rig constantly shook from the high pulsating characteristics of the pump discharge. To overcome the effect of gas pockets encountered in the earth strata, pumps are manifolded to develop greater pressure and volume. Accumulators have eliminated the severe

Fig. 11—Below—Accumulator-equipped hydraulic system for a large bus which assures both leakage compensation as well as emergency power



shocks resulting from this practice which created line failures and well explosions endangering the complete rig and its personnel.

There are many less spectacular illustrations of applications of accumulators as shock absorbers than those described in the foregoing. In machine tool applications, it is applied to eliminate chatter and fluctuations in table travel. In mobile agricultural machinery, snow plows and earth-moving machinery it provides smooth operation of the booms, plowheads, rams, etc.

As an Emergency Source for Fluid Power: In service where actuation is necessary for a short period of time, if the pump should fail or the primary hydraulic lines be incapacitated, the accumulator adequately serves as an emergency source of energy. Many such applications were developed during the recent war. In aircraft installations, pilots were able to land their airplanes safely with their pumps and supply lines shot away. In mobile tank and gun installations, the gunners were able to swing their turrets against an attacking enemy long after the engines which operated the pumps were incapacitated. This same technique is now being applied to large automotive vehicles such as trucks and busses where brakes, steering, door actuators, etc., are being operated hydraulically. If engine or pump failure should occur, sufficient energy can be stored in strategically located accumulators to accomplish safe operation of the vehicle or unit. Such a system for power steering, power brakes, and door actuators, is shown in *Fig.* 11.

It can be seen from *Fig.* 11 that the main pressure and return lines lead to three branch systems. A check valve is placed in each branch circuit as close to the distributor valve as possible and an accumulator is placed between the two. In this way, the accumulator can be charged from the pumping system but can exhaust only through the closed-center type control valves to the actuators. In cases where the accumulator is to be used as an emergency power source only, it is connected in the circuit with a manually operated check valve, as shown.

As a Means of Operating Secondary Circuits: When a circuit is employed intermittently in connection with a constant-duty circuit, actuators in this secondary circuit can be operated without affecting the speed or loading of the primary circuit, by proper use of an accumulator. For example, the simplified circuit of an automatic machine tool having a variable-speed drive spindle and a hydraulic bar-shifting mechanism, is shown in *Fig.* 12. It can be seen that the accumulator is used as a pressure source for actuating the bar-feeding cylinder and the speed-changing mechanism on the hydraulic motor by means of a solenoid-operated selector valve. This is possible because the secondary service requires but a small amount of fluid fed slowly and over wide ranges of time. Thus, the loading and speed of the hydraulic motor are not affected by the actuation of the secondary circuit. Accumulators can be used in the same way as a replenishing source on hydraulic drive and reversing circuits, as a prefill source, or in any place where a small quantity of fluid is required to compensate or complement the main hydraulic circuit.

Widens Scope of Hydraulics

As a Volume Compensator: The accumulator is now making possible many uses of hydraulic mechanisms which heretofore have not been feasible. This is especially true with closed systems where the danger of increased pressure due to thermal expansion of the fluid would cause rupture of the lines. The installation of an accumulator, precharged to the normal working pressure in the line, readily takes up the expanded volume and, more important, feeds it back into the lines as thermal contraction takes place. Hydraulic push-pull control mechanisms have been greatly complicated and limited in use due to thermal expansion problems. The application of accumulators with a high precharge should simplify them and extend their use.

A typical installation of accumulators to steel mill rolls

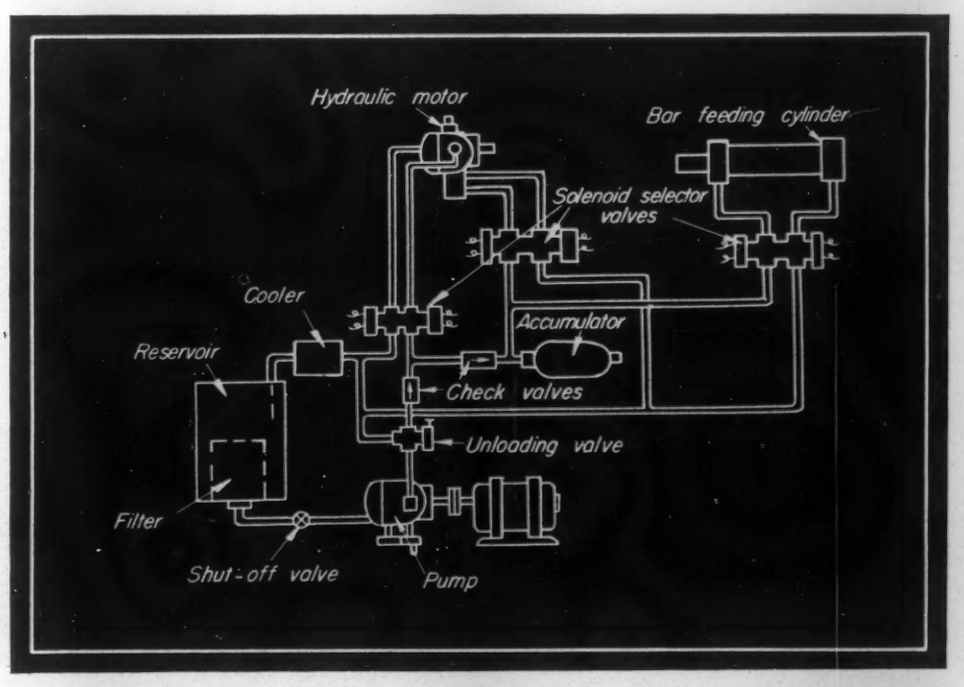


Fig. 12—Bar-feed cylinder and hydraulic motor speed-change mechanism in this automatic machine circuit are actuated by accumulator power

and sugar mill cylinders is shown in *Fig.* 13. The requirement here is that a constant pressure be applied to the rolls as the material passes through them. If foreign matter and solids pass through the mill, the top roll moves up to allow passage without breaking the rolls and then comes back to the same position under the same pressure as before. Hydraulic pressure against a piston is applied to the top roll through a thrust pad on the roll bearings. The pressure is supplied in conjunction with a series of accumulators having sufficient capacity so that, as the roll moves up or down, the fluid is taken up and released by the accumulators at very nearly constant pressure.

As a Fluid Dispenser: There are a great many ways by means of which an accumulator can efficiently and effectively feed fluids. Only a few can be mentioned here, but undoubtedly designers will find many other applications. In *Fig.* 14 is illustrated an installation where a small accumulator is used to supply lubricant continuously to a group of bearings in a mechanism. The lubricant is first pumped into the accumulator and passages of the mechanism from an external pumping unit through a standard grease fitting which contains a check valve. A sufficient quantity of lubricant at required pressure can be charged into the unit and by selecting the proper size accumulator it can then be depended upon to supply lubricant over a long period of time, thus eliminating the need for constant attention and maintenance. In a machine that has a great many points of lubrication, a similar accumulator arrangement can be set up with lines leading from a manifold connecting to all grease or lubrication fittings on the machine.

In automobile, truck, and rail car installations where constant pressure application of lubricant will overflow, the unit can be charged and the lines filled leaving the air chamber of the accumulator open to atmosphere. An air pressure line can then be connected to the air valve in such a way that by applying air pressure to this line at required intervals and in sufficient quantities, all the lubricating points can be serviced at one time, *Fig.* 15.

As an Auxiliary Source of Energy in Intermittent Duty Systems: The hydraulic system designer, with

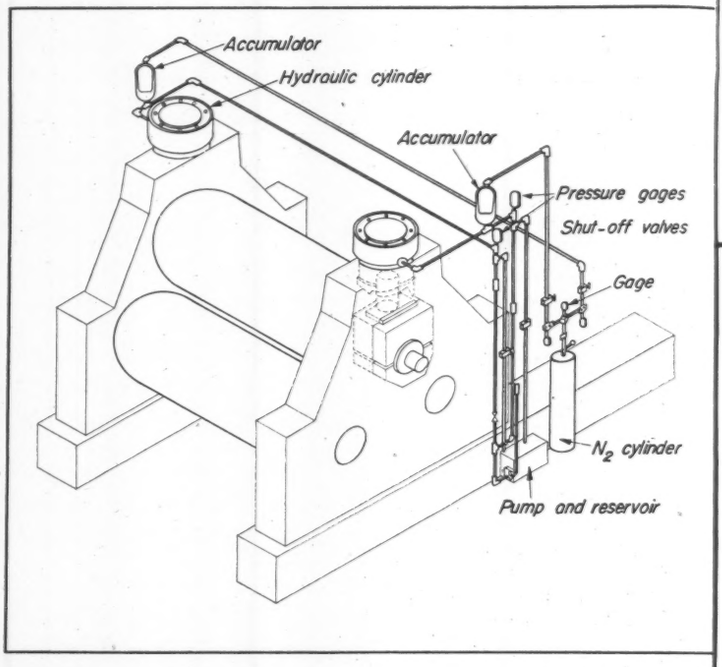


Fig.13—Typical installation of accumulators in a constant-pressure hydraulically loaded mill roll arrangement

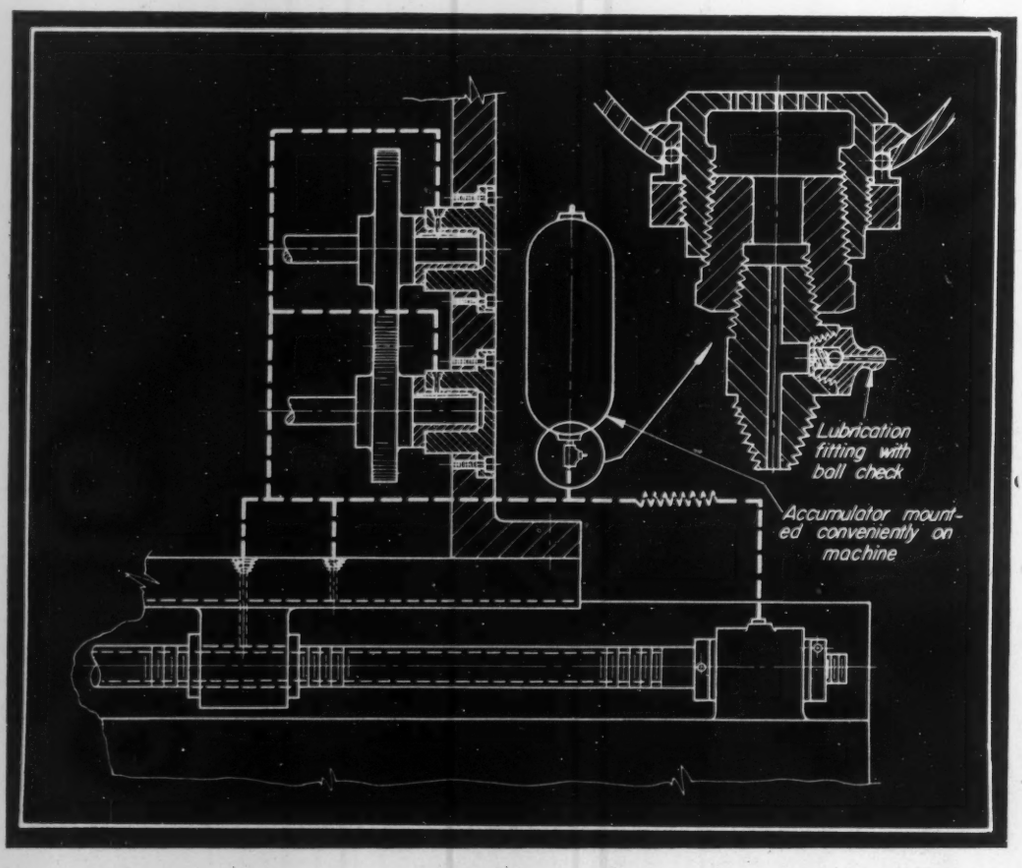


Fig. 14 — Accumulator arranged to provide a continuous supply of lubricant to a group of machine bearings

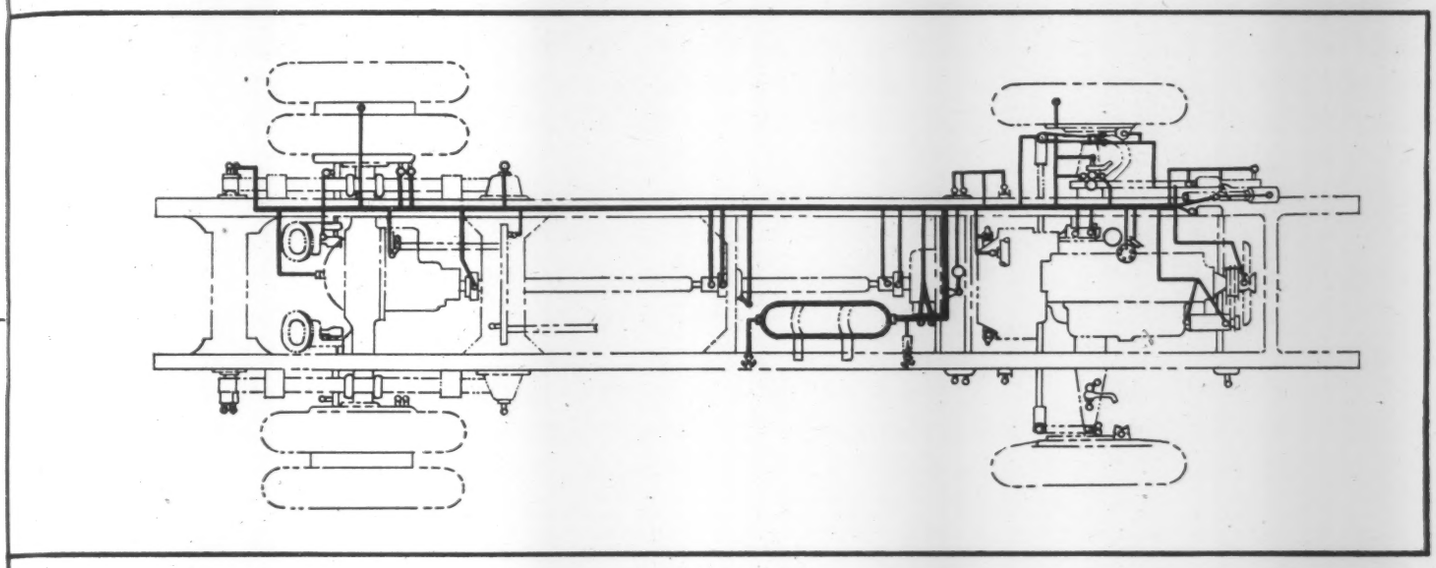
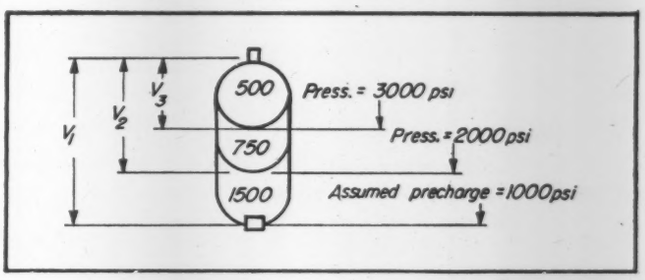


Fig. 15—Above—Accumulator arranged to allow one-shot lubrication of all points on a truck chassis

Fig. 16—Below—Diagram showing pressure-volume relationship within a hydropneumatic accumulator



complete knowledge on the application of accumulators, can reduce substantially the complexity and power required to do a given job as well as, in many instances, completely eliminate costly valves, controls, motors and pumps. This is because most hydraulic systems operate on an intermittent duty basis and the power supplied to the circuit normally is based on the requirements of the maximum work cycle. This cycle usually is of relatively short duration and during the longer remaining period, the power in most circuits not employing accumulators is wasted. An outstanding example will serve to illustrate the point.

A press is required that will exert 50 tons pressure over a three-inch stroke in one second. Also, a 5-inch working space for loading dies is desired. To begin, a pump capable of delivering 3000 psi is selected arbitrarily. Under ordinary circumstances, not considering the use of an accumulator, the design would run like this: The required 50 tons (100,000 lb) divided by 3000 psi gives a piston area of 33.333 sq in. or a 6.52-inch diameter cylinder bore. Using the next largest commercial size, a 6.750-inch cylinder, which has an area of 35.78 sq in., is selected with a working stroke of 5 inches. Therefore, calculating for capacity to meet 3-inch stroke per second, $35.78 \times 9 = 107.34$ cu in. per second $= 107.34 \times 60 =$ 6440.40 cu in. per minute. Thus the flow required $=$ $6440/231 = 27.8$ gallons per minute, and the horsepower required $= 27.8 \times 3000 \times 0.000583 = 48.6$ hp. As can be seen, it is necessary to use a 50-hp pump motor.

Smaller Motors Can Be Used

Now let it be assumed it takes 2 minutes to load and unload the die for the complete cycle. Therefore, under this intermittent time cycle, an accumulator can be used and the design would proceed as follows: Since maximum pressure available from the pump is 3000 psi, minimum operating pressure available from accumulator is chosen as 2000 psi; to obtain a 100,000-lb load with 2000 psi, the piston area required $=$ 50 sq in. Therefore, in this case it is necessary to use an 8-inch actuating cylinder (area $=$ 50.27 sq in.) with stroke of 5 inches. To determine flow rate required, $50.27 \times 3 = 150.81$ cu in. per second or approximately 9000 cu in. per minute or 38.96 gpm, and the total volume required for operation $= 50.27 \times 5 = 251$ cu in., say 250 for simplicity.

Inasmuch as full pressure and flow requirements are desired from the accumulator neglecting the flow of the pump, the accumulator size required must be also determined. Referring to the sketch in *Fig.* 16, it can be assumed for purposes of calibration that the air in the accumulator acts in accordance with Boyles' law for gases with PV = a constant, and $P_1V_1 = P_2V_2 = P_3V_3$. But, since $V_2 = V_3 + 250$, $P_2(250 + V_3) = P_3V_3$ or 2000 $(250 + V_3) = 3000\ V_3$, from which $V_3 = 500$ cu in. However, $P_1V_1 = P_3V_3$, or $1000\ V_1 = 3000 \times 500 = 1{,}500{,}000$, from which $V_1 = 1500$ cu in. or approximately 6.5 gallons. The nearest size commercial accumulators are 5 gallon and 2½ gallon, so the obvious thing is to choose 7.5 gallon capacity in two accumulators or 1740 cu in.

In actual operation, since $V_1 = 1740$ cu in., $1740\ P_1 =$ 1,500,000 and P_1 = approximately 860 psi precharge pressure. Now, since there are 2 minutes in which to reload the accumulator with 250 cu in. of fluid and to assure adequate safety factor it is assumed 1.5 gallons are required, the actual capacity is 0.75 gpm. In this case the required hp $= 0.75 \times 3000 \times 0.000583 = 1.31$ hp and a 1.5-hp motor can be substituted for the 50-hp normally required in the circuit as shown in *Fig.* 17.

Discharge of the pump, *Fig.* 17, is delivered to an unloader or pressure regulator valve, set at 3000 psi, in such

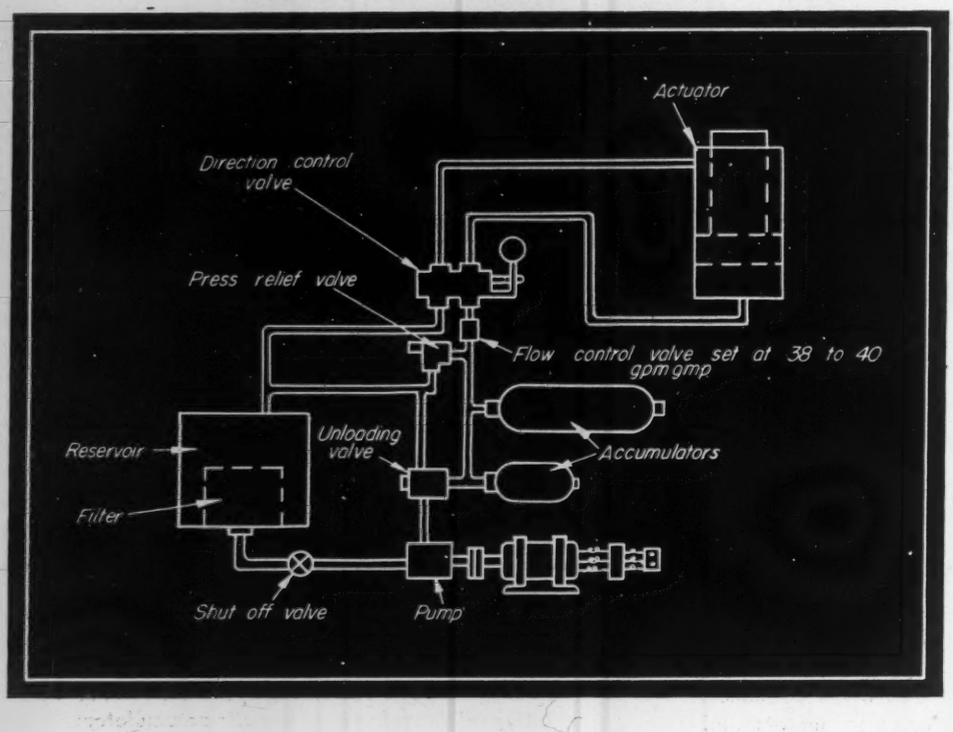
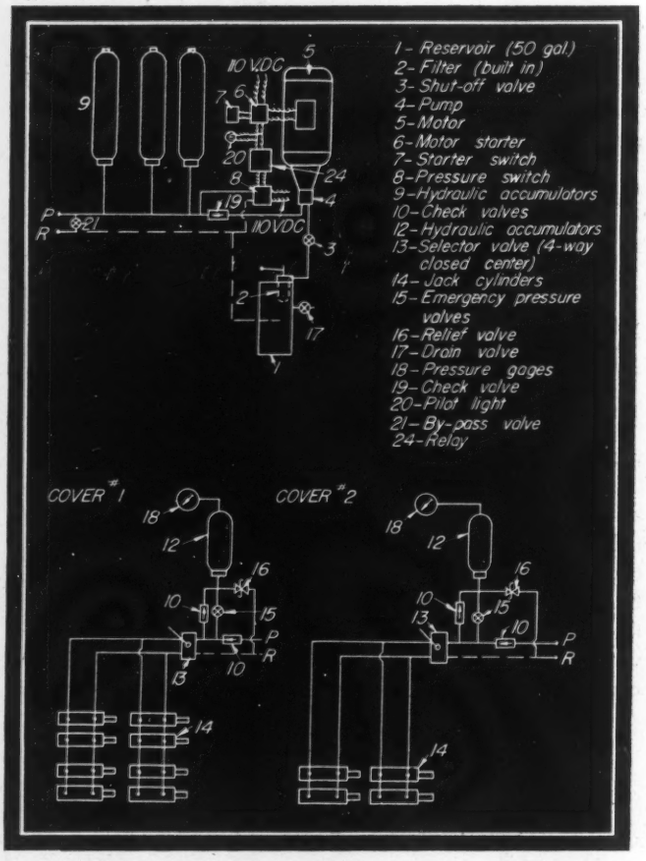


Fig. 17 — Left — Intermittent-duty hydraulic circuit can be adequately powered by a 1.5-hp pump drive motor but requires 50-hp when no accumulators are used

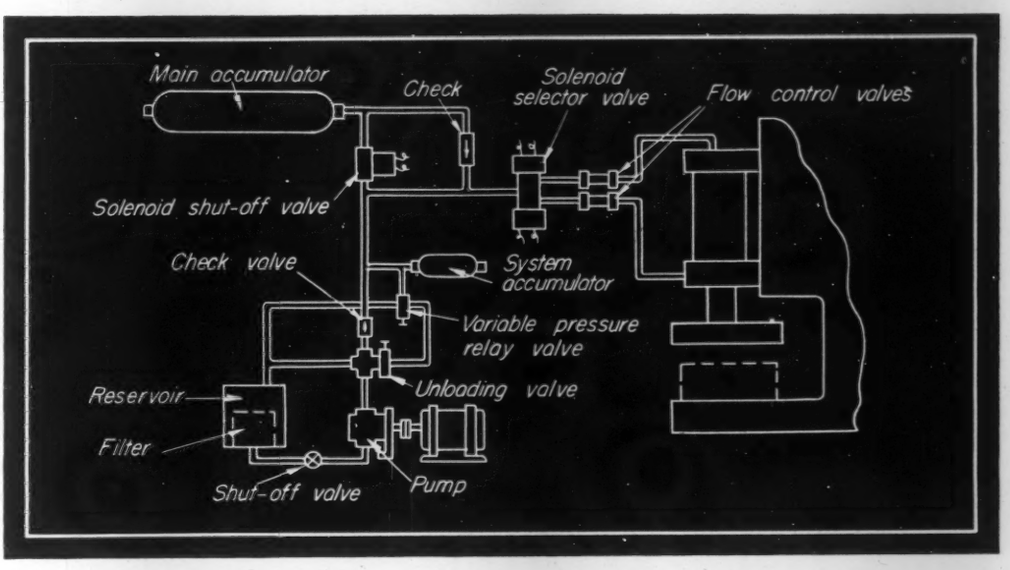
Fig. 18—Below—Low horsepower hydraulic system for operation of cargo hatches on freight vessels



a manner that as long as the accumulators in the line are charged to 3000 psi, the valve by-passes the pump flow at zero pressure into the reservoir and, in the meantime, holds pressure in the accumulators. As the pressure drops 5 to 10 per cent, the pump cuts into the accumulators again. By operating the directional control valve, the flow from the accumulators is directed into the actuator. The rate of flow is determined by the back pressure or pressure drop through the selector valve on lines leading from the accumulators to the actuator. Due to the full-flow plug design of the accumulator, the flow can easily exceed 75 gallons per minute. Therefore, a flow control valve, set at 38 to 40 gpm, is placed in the line to meet the flow conditions calculated above.

Similar accumulator circuits can be utilized to raise bridges, actuate heavy doors, or control large and small presses, machine tools, and road and farm machinery, with a tremendous saving in horsepower required. This, of course, results in considerable decrease in original equipment cost, size of the installation, as well as maintenance and operating costs. An interesting illustration of a practical application of this type circuit is shown in *Fig.* 18. This is a schematic diagram of a hydraulic system designed by Greer Hydraulics for operating a cargo hatch closure. Due to the extremely heavy hatch doors and the time limits required in operation, a normal capacity of over 50 hp would be required. Inasmuch as the complete system must be enclosed within the hatch covers, such an installation would be totally impractical without the use of accumulators, especially considering the number of hatches used. Using accumulator systems with one or two horsepower per closure, the problems of wire sizes, conduits, explosionproof motors and connectors are greatly simplified. Attention is called to the use of a pressure switch in connection with the accumulators in this system. The pump charges the accumulators to the required maximum pressure and at this point, the pressure switch opens the electric circuit, thus shutting off the electric motor. When the pressure drops 5 to 10 per cent, the switch closes the circuit, starting the motor. In this way the motor is operating only to supply fluid pressure when required and stands ready to work at all times. This type of circuit is highly efficient and effective and allows the use of hydraulic systems on long-period intermittent service without consumption of energy except when the

Fig.19 — Right — Hydraulic circuit diagram for a plastic molding press which utilizes several accumulators to achieve automatic sequence operation



hydraulic system is actually doing work.

Accumulators for emergency stand-by service are also illustrated in *Fig.* 18. Fluid pressure is charged into the stand-by accumulator through a hand-operated check valve so designed that all fluid passing through it is trapped beyond it. For emergency operation, the valve is operated manually to open the check valve to reverse flow, thus supplying fluid power to do useful work.

There are many hydraulic system requirements for heavy duty clamping, holding, etc., where a heavy load must be instantly applied and held constant for a period of time. In this type circuit, a hydraulic ram with sufficient piston diameter must travel to the holding die and then apply full load instantly and hold it. An accumulator system designed to meet just such requirements is illustrated in the plastic molding press setup shown in *Fig.* 19. This particular system makes possible: (1) Prefill of the actuating ram at a rate of flow much higher than the capacity of the pump, (2) instantaneous flow at pressures required to actuate the ram only, (3) reduction of horsepower requirements, (4) instantaneous high holding pressures, (5) adjustable maximum unloading pressure, and (6) controlled flow for constant ram travel.

Automatic Circuit Operation

With reference to *Fig.* 19, it can be seen that a small capacity pump draws fluid through a filter from a reservoir and discharges it through a sequence relief valve and check valve to a normally open solenoid shut-off valve. A branch system leads to a small accumulator which is connected to a relay valve which, in turn, is connected to the sequence valve in such a manner that when the set pressure of the relay valve is developed in the small accumulator, it vents the sequence relief valve to the reservoir, thus unloading the circuit. The check valve maintains the pressure in the circuit while the pump is unloaded. Just ahead of the solenoid shut-off valve, the main line branches into a four-way closed-center selector valve. The opposite end of the solenoid shut-off valve is connected to the main accumulator and branches through a large check valve into the main feed line to the selector valve. From the selector valve, connections are made through flow control valves to the actuating ram.

By operation of the electric pushbutton, a solenoid on the four-way selector valve is energized, actuating the valve so that flow of oil from the main line is directed through the flow control valve to the upper chamber of the ram causing downward movement. At the same instant, the solenoid on the shut-off valve is energized and cuts off the flow from the pump to the main accumulator. The fluid in the accumulator is directed, under precharged pressure, through the check valve into the main line which is also receiving fluid from the pump. When the ram hits the die, a higher pressure than that which is in the accumulator is immediately developed by the pump, thus closing the main check valve to the accumulator and resulting in immediate maximum pressure, as preset in the unloading circuit, at the ram piston which can be held steady for long periods of time by virtue of the action in the small accumulator. This is considering, of course, that no ram movement results after the die is hit. Releasing the contact on the electric pushbutton or operation of a second switch through electric relays reverses the selector valve by energizing the opposite solenoid and de-energizing the solenoid on the shut-off valve, thus opening the flow to the main accumulator.

There are naturally a great many more applications for hydropneumatic accumulators than can be discussed in this article. This unit is a newcomer in the industrial hydraulic field and as time goes on more and more applications for its use will be found. It is safe to state that wherever fluid flows in lines under some known rate and pressure, a great deal of consideration must be given the use of pneumatic accumulators to improve the action of the circuit, cut down size of pumps and motors, and reduce costs both in equipment and operation as well as maintenance.

CORRECTION: In the article, "Inertia Wheel Absorbs Shock", on Page 111 of the April issue, the inertia wheel makes possible a circuit breaker that will withstand mechanical impacts up to 2000 foot-pounds instead of up to 200 as stated.

Graphical Solution

. . . to the problem of connecting two lines by a third line which makes specified angles with each

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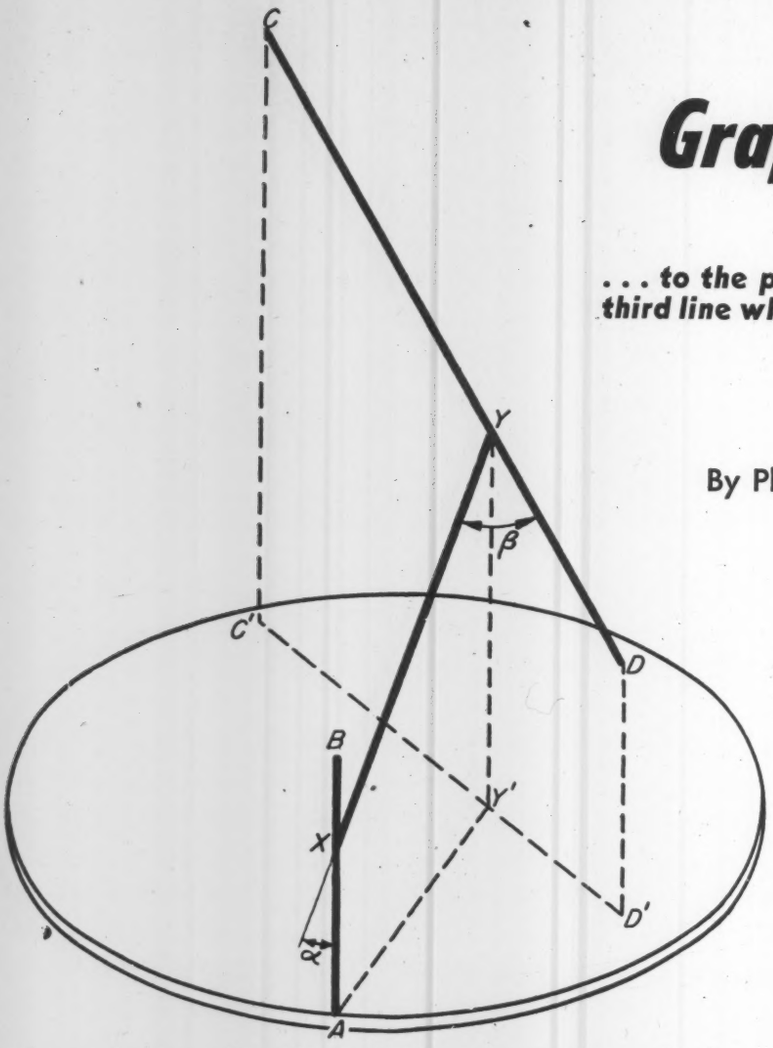

Fig. 1—The problem is to find a line XY which makes specified angles with two nonparallel, nonintersecting lines AB and CD

PROBLEM of constructing and measuring the common perpendicular to two nonintersecting nonparallel lines is frequently met in the drafting room, and is usually illustrated in conventional texts on descriptive geometry. However, a connection that makes other than 90 degrees with each given line is not so readily found. So far as is known, the graphical solution to this problem is not treated in any published text. It has many practical implications, as for instance when two hydraulic lines are to be cross connected by 45-degree fittings. In such cases employment of 90-degree fittings (the common perpendicular) would cause greater friction loss and perhaps objectionable shock.

In the pictorial illustration, *Fig.* 1, the two given lines are *AB* and *CD*. The connection *XY* is to be so constructed and located that it makes a specified angle α with line *AB*, and angle β with *CD*. The solution of course requires finding the exact locations of points *X* and *Y* on the given lines. As the angles α and β increase toward 90 degrees the connection would approach the common perpendicular position.

In *Fig.* 2, two orthographic projections of such lines are shown, with *AB* assumed perpendicular to the plane of the top view (horizontal plane). The solution is predicated on this assumption. It is only an elementary operation to employ one or two auxiliary views to obtain the point projection of an oblique line, and it is taken as the starting position here just as it is logically utilized in obtaining the common perpendicular.

ANALYSIS AND SOLUTION: A line *MN* parallel to *AB* is assumed to intersect *CD* at any convenient point, say *D*, *Fig.* 2. A line *DK* can then be found, as explained later, passing through point *D* and making required angles α and β with *MN* and *CD*, respectively. This line will be parallel to the required connecting line *XY*. In the illustration, α is chosen as 60 degrees and β as 45 degrees.

The line *DK* is found as the intersection of two right circular cones, having a common apex at *D*, the axes of which lie along *MN* and *CD*, respectively. The angle between the elements and *MN* for one cone is the specified angle α, and the angle between the elements and *CD* for the other cone is angle β. These cones will be referred to as the α-cone and the β-cone.

If the slant height of each cone, that is, the length of the elements, is taken the same on both cones, the base circles will intersect each other at some point (or points), which with *D* determines a common intersection of the cones, i.e., line *DK*.

In the top view, where *AB* shows as a point, the required connection can then be drawn from *AB* parallel to *DK*, until it intersects *CD* at point *Y*. With point *Y* known, *XY* can be drawn parallel to *DK* in the adjacent view, and will intersect *AB* at point *X*. Since *DK* makes angles α and β respectively with *MN* and *CD*, the line *XY* (from parallelism) makes these same angles with *AB* and *CD*.

Angles α and β can have the same value, such as 45 degrees as was mentioned for pipe fittings, or they can be

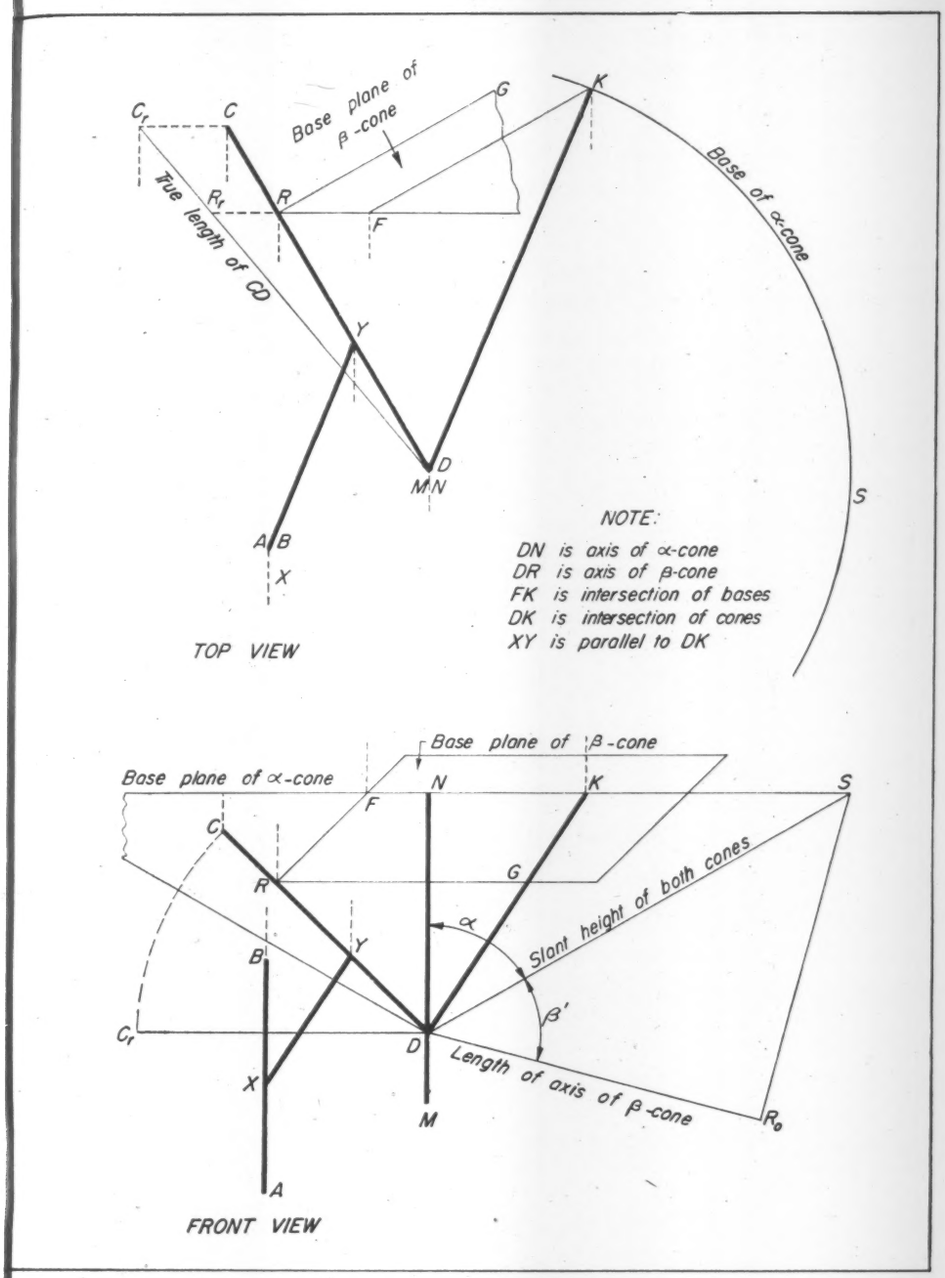

Fig. 2—Orthographic solution to the problem stated in Fig. 1 involves construction of two cones with axes on or parallel to the lines AB and CD and with vertex half-angles equal to the specified angles

along DC and its elements making angle β (45 degrees) with the axis. The slant height must be the same as for the α-cone. The necessary length of axis is shown constructed in the front view as DR_o, where the required slant height DS has already been established, and where the angle β' $(=\beta)$ may be drawn between DS and DR_o. Find the true length of CD by revolving the line to a horizontal position DC_r in the front view, the true length then being obtained in the top view. On this true length lay off DR_r equal to the axis (DR_o) of the β-cone. Locate point R from R_r, giving a point in the base plane of the β-cone.

The base plane is established by drawing two lines through R, both of them perpendicular to axis DR. One line is RG, a horizontal line as drawn in the front view, and therefore drawn perpendicular to DR in the top view. The other line is RF, parallel to the front view and therefore perpendicular to DR in the front view.

Intersection of the base planes of the two cones will be a line that crosses the base curve of the α-cone at a point (or points) which would be common to the two cones and therefore on their common element (or elements). It is not necessary to draw the actual base curve of the β-cone. Point F (obtained in the front

different. There is a minimum limitation, however, to the sum of the two values. In the diagram of *Fig.* 1, the sum $\alpha + \beta$ must be greater than $180° - \theta$, where θ is the projected angle between AB and CD. The angle θ does not appear in the illustration but may be defined as the angle between CD and the projection of AB on a plane parallel to AB through CD. The sum could be as small as $180° - \theta$ only as the perpendicular distance decreases to zero, or as points X and Y move to infinity.

DETAIL CONSTRUCTION: In the given lines AB and CD of *Fig.* 2, AB has its projection in the top view as a point. Through point D in the front view draw MN parallel to AB and of any convenient length. Let DN be the axis of a right circular cone whose elements make angle α (60 degrees) with the axis. This is the α-cone, and it shows as a circle of radius NS in the top view and an isosceles triangle in the front view having a slant height of DS.

The β-cone must then be established, with its axis lying

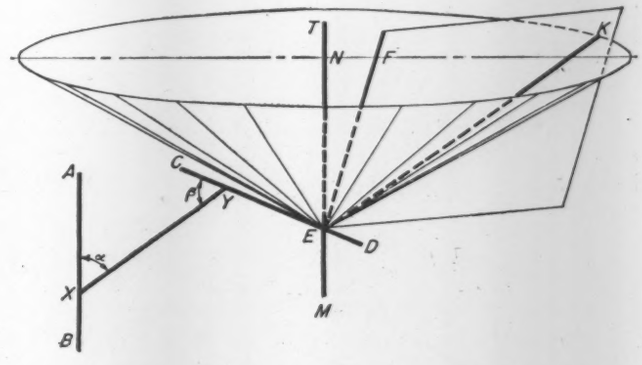

Fig. 3—Pictorial representation of the solution when one of the specified angles is 90 degrees with the result that the corresponding cone becomes a plane

view) is obviously a point on the intersection of the two base planes. The line of intersection is *FK*, drawn parallel to *RG*. Point *K* is the intersection (top view) with the base circle of the α-cone. Connect *D* to *K* in both views. The line *DK* is then the common element of the two locus cones, and therefore makes angle α and β respectively with *MN* and *CD*.

In the top view, line *XY* is drawn from *AB* parallel to *DK*, intersecting *CD* at point *Y*. Point *Y* is then located in the front view on *CD*, and *XY* drawn parallel to *DK*. This determines the location of point *X* on *AB*.

When One Angle Is 90 Degrees: In the foregoing discussion, the solution was applicable to angles of any value up to 90 degrees. Neither angle can be exactly 90 degrees, however, since the two locus cones could only be formed when the apex angle (between axis and the elements) has some value less than 90 degrees. The question arises as to how the solution can be found if one given angle is 90 degrees, and the other one some oblique value, say 60 degrees, as pictorially illustrated in *Fig.* 3. *AB* and *CD* are the two given lines and *XY* is the final line making angle $\beta(=90$ degrees) with *CD* and angle $\alpha(=60$ degrees) with *AB*.

As before, a line *MT* parallel to *AB* is drawn intersecting *DC* at any convenient point *E*. A trial line *EK* which makes the given angles with *CD* and *MT* is first found. *XY*, drawn parallel to *EK*, makes the same angles with *CD* and *AB*.

To find *EK*, a cone is established with apex at *E* and axis *EN* (on *MT*), having an apex angle between the axis and the elements $\alpha = 60$ degrees. The cone is the locus of all lines at 60 degrees to *EN* through point *E*. Next, a plane perpendicular to *CD* at point *E* is established. This is the locus of all lines perpendicular to *CD* at point *E*, and takes the place of the β-cone set up in the general case previously presented. The intersection *EK* of the locus cone and the locus plane will therefore be a line making the specified angles with *CD* and *MT*.

Detail Construction Explained

Orthographic Solution: *Fig.* 4 shows the exact solution in two orthographic projection views. The drawing gives one of the lines, *AB*, projecting as a point in one view. As pointed out before, this condition is always easily obtained in a drawing by the elementary principle of auxiliary views.

Line *MT* is drawn parallel to *AB* through any point *E* on *CD*. *E* is the apex of the locus α-cone, with an axis of any convenient length *EN*. In one view the cone shows as a circle, and in the other view as an isosceles triangle formed on the angle $\alpha = 60$ degrees, as shown.

The locus plane, 90 degrees to *CD* at point *E*, is formed by the two lines *EQ* and *EF*, both perpendicular to *CD*. Intersection of the plane and the base of the cone starts at point *F*, and is *FK* (parallel to *EQ*). Joining point *K* to *E*, this line represents the intersection of the locus plane and the cone, and therefore makes the angles of 60 degrees and 90 degrees respectively with *MT* and *CD*.

In the view where *AB* shows as a point, *XY* is drawn parallel to *EK*. It intersects *CD* at the point *Y*. *Y* thus found in the other view will permit drawing *XY* parallel to *EK*. *XY* then makes the given angles with *AB* and *CD*, and the points of intersection *X* and *Y* are exactly determined from the drawing.

When Both Angles Are 90 Degrees: In this case the problem is easily and conventionally solved without bringing in either of the locus surfaces. *XY* will project at exactly 90 degrees to *CD* in the top view (where *AB* shows as a point), and at exactly 90 degrees to *AB* (horizontal) in the adjacent view where *AB* is a vertical true-length line.

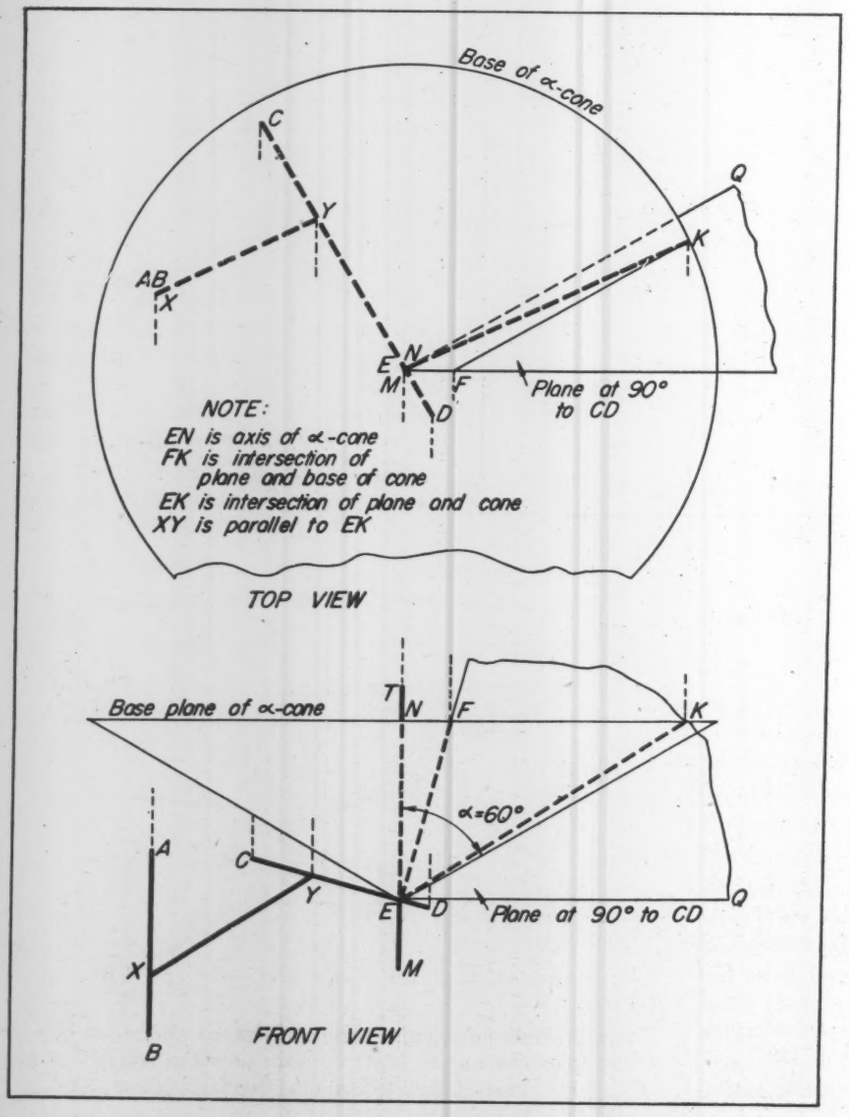

Fig. 4—Orthographic solution to the problem illustrated in Fig. 3

Designing for Pneumatics

Part II–Pressure Selection and Receivers

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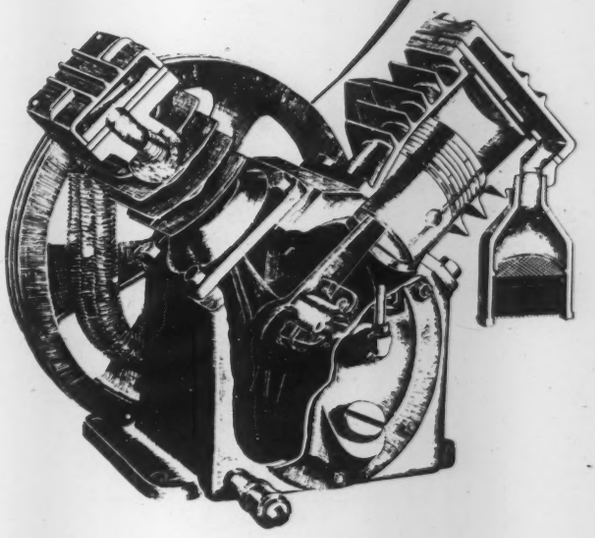


IN APPLYING or designing a pneumatic system the operating pressure is the first thing that must be determined. The nature of the job to be done, the overall efficiency, the size and weight of the equipment, the cost, the safety, and the permissible amounts of water or oil in the air all influence the selection of the operating pressure.

Some applications definitely establish the operating pressure so that a rigorous analysis to determine the optimum operating pressure is unnecessary. An air lift type deep well pump, for example, definitely establishes the air pressure by the head of water it must overcome at start. In low-pressure molding of some types of thermosetting plastics, air pressure is used to "load" the parts being molded. Pressure limitations exist both in the load on the parts and in the diaphragm or bag itself. In fact, most applications use equipment already designed for a given operating pressure, so that a free selection usually cannot be made.

Overall efficiency is affected by the operating pressure or, more correctly, by the ratio of compression in any system, but especially so in systems where the major air demands are from air cylinders, small pneumatic motors, percussion hammers, or other devices that do not expand the air to an appreciable extent. *Fig.* 9 shows the highest possible efficiency in a system where the air is used at ambient temperature with no expansion. Full air pressure is admitted to a cylinder, for example, throughout the full stroke, then dumped to atmosphere when a return stroke is made. The curves are based on actual compressor performance using air-cooled compressors, approximating 10-horsepower, operating at 600 to 900 rpm. Clearance and leakage losses in the valves, lines, and cylinder ends were not included. Since it is not practical in any application to expand the air fully and since the air is almost always cooler when it is used than when it leaves the compressor, the overall

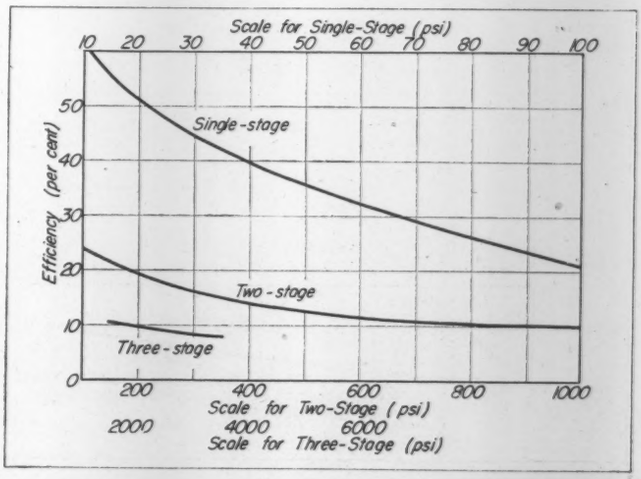


Fig. 9—Operating pressure vs overall efficiency assuming same temperature at intake of compressor and cylinder, no expansion, no valve or line losses, sea level

efficiency is always lower at higher operating pressures. Leaks which definitely contribute to inefficiency are proportionately greater at increased pressure as shown in *Fig.* 10. There are practical limitations on the minimum clearance and line volumes for cylinders and for piston type air motors, so these losses are also greater at higher pressure ratios. Hence, from the standpoint of overall efficiency, the lowest possible pressure is recommended.

Unusual Adaptability to Weight Requirements

As in hydraulic or electric systems the size of the components are reduced by higher pressures—except for the compressor proper. Unlike hydraulic fluid, the weight of air required to do a given job is the same regardless of the operating pressure if no expansion is used. A pneumatic cylinder which will produce a 2000-lb thrust with a one-foot stroke must have an inside diameter of 5.05 inches for 100-psi air which with 0.035 cu ft of volume, requires 0.0167 lb of air per stroke (from Equation 1). A cylinder to do the same job with 3000-psi air has an inside diameter of only 0.92-inch and an internal volume of 0.0064 cu ft but requires the *same* weight of air. This means that the compressor to handle the job must have the same intake capacity regardless of operating pressure. Since higher pressures require multistaging and intercooling, the compressor becomes larger, heavier, and more expensive, *Fig.* 11. However, in some applications such as aircraft, space is at a premium and storage pressures as high as 4000 psi are being considered mainly to be able to get the equipment into the space available. The air receivers are usually the largest piece of equipment in the system. To store a given weight of compressed air the receiver volume is inversely proportional to the pressure. The diameter of a cylinder to produce a given force is inversely proportional to the square root of the pressure.

The weight of compressor equipment for large, permanent installations is unimportant as is evidenced by the size, low speed and heavy cross sections, with the generous use of gray cast iron, in this class of unit. Although compressed air has been used in railroad equipment for years, to date there has been no critical limitation on weight. Many railway cars are still equipped with cast-iron air receivers, although more pressed steel tanks are now being used.

With the advent of compressed air applications in the automotive and aircraft fields, however, reduction of weight has become extremely important. Compressors for this classification can be designed along aircraft engine lines for operation at increased speeds to effect weight reduction. The pneumatic system for aircraft is the lightest possible means for handling large intermittent-duty ancillary power loads. It could be used equally well in other applications where weight is important.

It can be shown, however, that the operating air pressure of these systems has little influence on the overall system weight when the system is properly designed. Actual comparisons show that a 3000-psi aircraft pneumatic system was no lighter in weight than a properly designed 500-psi system for the same job and no penalty was incurred by operating at lower pressure. As previously pointed out, the weight of compressed air required to handle a given job is the same regardless of the pressure. This is in contrast to hydraulic systems wherein the use of high pressure results in an appreciable decrease in fluid volume and considerable weight reduction.

From *Fig.* 12 it can be seen that the weight of the air receivers is not reduced by using pressures above 300 psi because the wall thickness increases even though volume is less. This also applies to tubing and cylinders. In most aircraft applications the smallest practical line size

Fig. 10—Brake horsepower required to maintain leakage through a 0.015-inch diameter sharp-edge, round hole

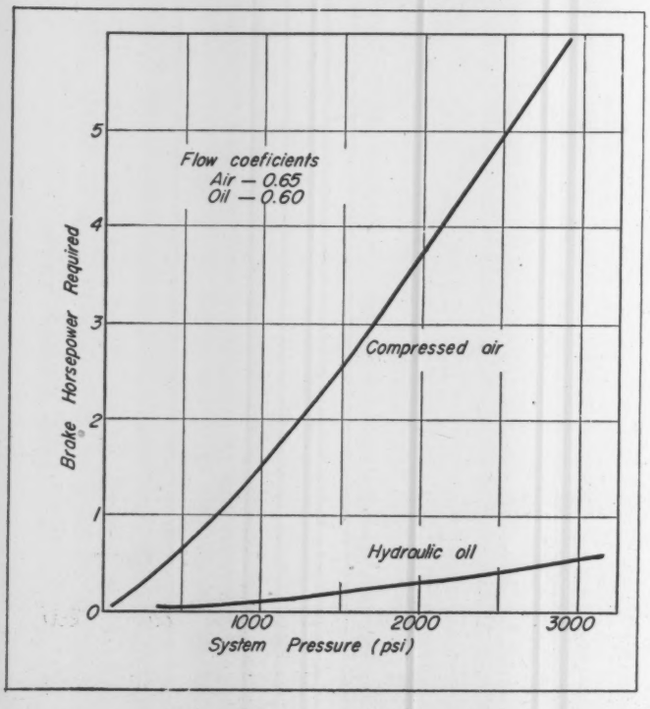
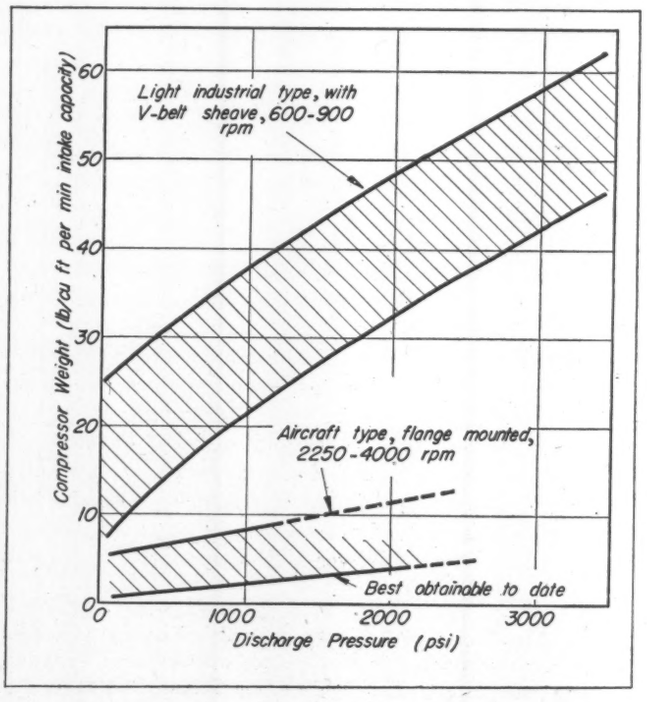


Fig. 11—Approximate weight of bare, aircooled compressors at sea level. Figures represent many makes and designs and are intended to show the weight trend only



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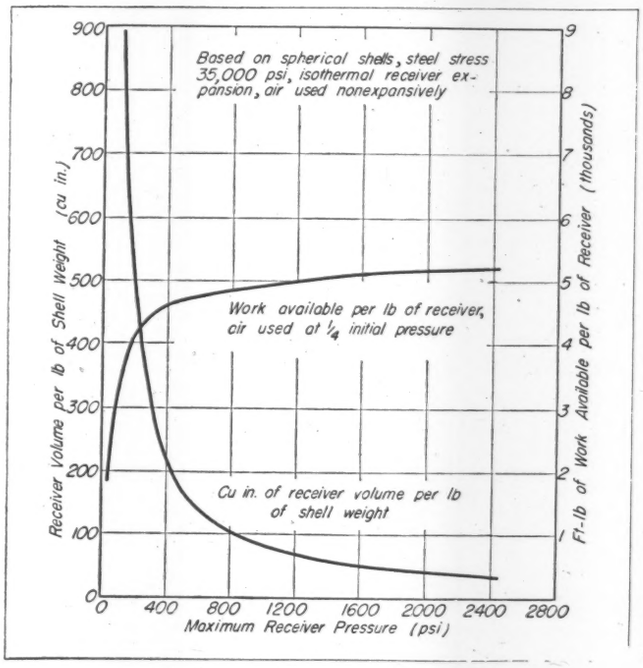


Fig. 12—Volume and work available per pound of receiver for aircraft type air receivers

is used at 500 psi so the line weight would increase at 3000 psi because tubing wall thickness must be increased.

Compressor weight also increases with increased system operating pressure. To do a given job the same intake capacity must be handled and additional intercoolers, stages, and regulating complications are introduced when higher operating pressures are used. Too, compressor reliability is reduced at higher pressures because of these added complications. The weight of aircraft type engine-driven air compressors and lightweight commercial V-belt-driven air compressors as designed for various operating pressures is shown in *Fig.* 11.

Because of reasons cited thus far, it should be obvious that the cost of compressed air equipment usually is increased when high pressures are used. Safety is probably reduced, but this varies so much between installations that no comparison can be made. However, as is indicated in *Fig.* 1, more oil and water vapor can be removed at increased pressures, and this may well be sufficient reason to select a high operating pressure for special applications even though the air is expanded through a pressure-reducing valve to some lower pressure before use.

Standard Pressure Widely Used

TYPICAL SYSTEM PRESSURES: The average shop or plant compressed air system operates at a pressure of 90 to 125 psi for several reasons:

1. Compressors for this pressure are simple and reliable, and can be either single or two-stage
2. Standard pipe and fittings can be used
3. Hand-held tools using this pressure are smaller and give better performance than either standard frequency or high-cycle (180 cycles) electric tools. There is consideration being given, however, to higher pressures for hand-held pneumatic tools to further reduce tool size and weight and increase the worker's efficiency at a slight loss in overall transmission efficiency
4. This pressure was within the limits of commercial hose at a time when the art of hose manufacture was not as developed as it is today
5. It is sufficient pressure for blowing, cleaning, and paint spraying
6. The pressure is high enough to effect removal of most harmful water when aftercoolers and separators are used.

Compressed air at about 100 psi is so universally used that it is one of the few pressure ranges for which many

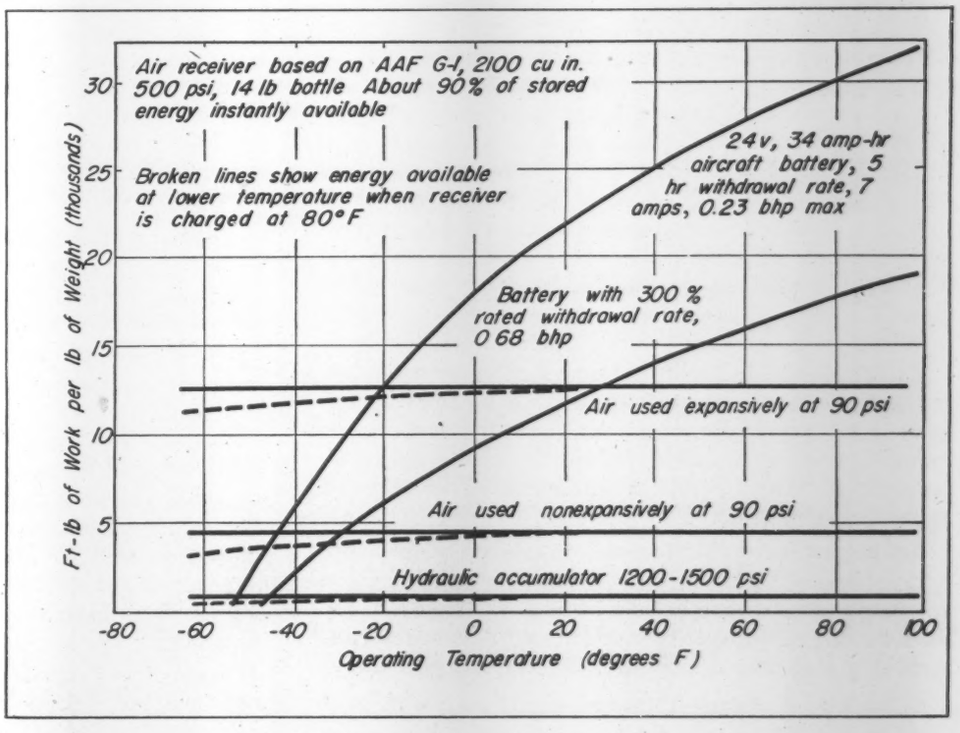


Fig. 13—Right—General comparison of various energy storage systems

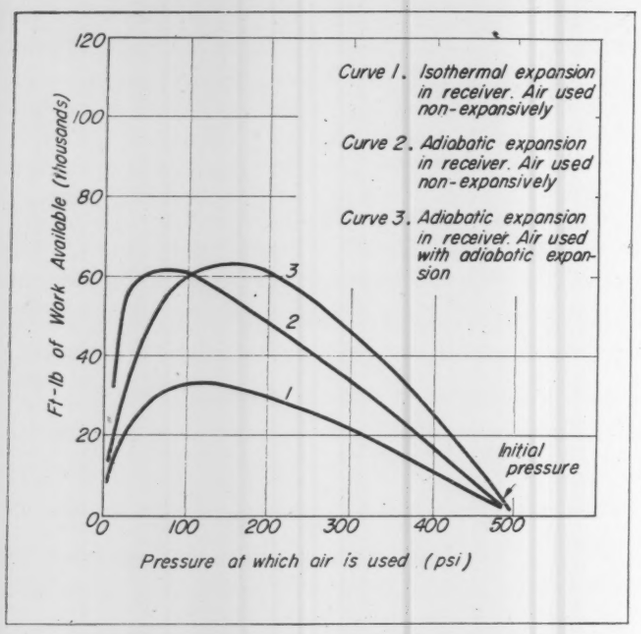


Fig. 14—Energy available in a 500 psi air receiver based on a 2100 cu. in. volume unit. Most applications fall somewhere between curves 1 and 2

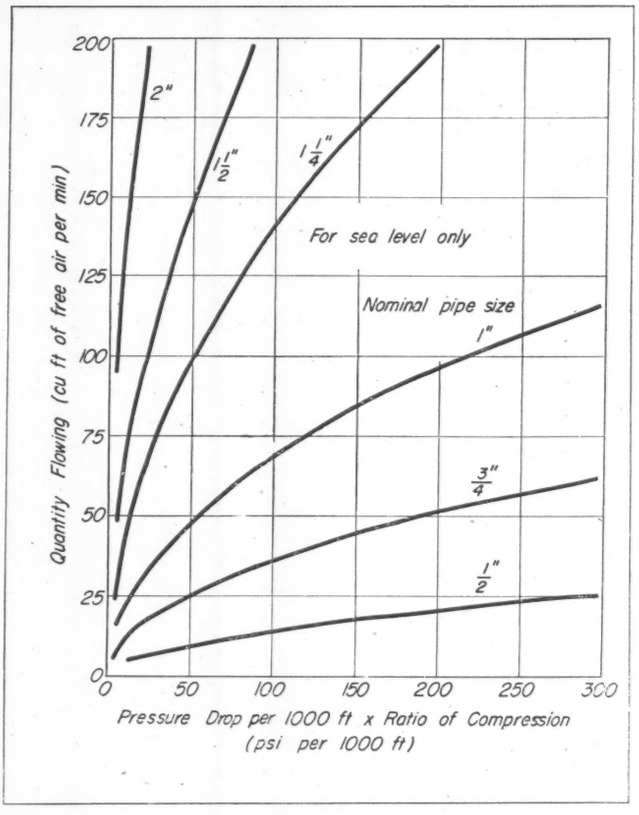


Fig. 15—Friction of air in pipes for common line sizes

production air compressors are designed and built. Because it is widely accepted as a standard pressure, the majority of tools, special fittings, motors, etc., are also designed for it. Most tools are rated at 90 psi to allow for line losses.

Automotive service stations and garages carry compressed air at 180 to 250 psi for two major reasons: (1) These pressures are needed to expedite tire filling with small, convenient air hoses, and (2) there is considerable pressure drop available from the receiver so that a car can be hoisted or a set of truck tires filled without having the compressor start and stop too frequently. Because these higher pressures are available, the entire system must be designed to handle them safely even though some devices do not necessarily need the high pressure to function properly.

Aircraft pneumatic systems are too new to say what the trend in pressure will be. Some are talking about 2000 to 3500 psi systems while others are applying systems in the 500 to 1500 psi range. As previously pointed out, however, it is definitely advantageous to use the lowest pressure commensurate with the space available since the overall weight is almost unaffected by the pressure selection.

Where air is used for accurate control work, low pressures are essential largely because the forces acting on smallest practicable size valves, pistons, etc., at high pressures is too great. Pneumatic boiler control systems, for example, store air at about 100 psi but use it below 50 psi to obtain close control. Moisture and oil are removed at the higher pressure.

Air Receivers: The air receiver is primarily an energy storage device. Because it is a pressure vessel without any diaphragms or internal mechanism whatsoever, it has the following advantages over other energy storage devices such as a hydraulic accumulator and an electric battery:

1. Simplest in design—a pressure vessel only with no plates or diaphragms
2. May be any shape or size—even the pipes leading to and from the receiver store energy
3. Weighs less than any other energy storage device for moderate or high withdrawal rates, *Fig.* 13
4. Most reliable—very little servicing required
5. Can hold pressure charge indefinitely or can remain uncharged without damage
6. Extremely small output variation with temperature change, *Fig.* 13
7. Rate of charge or withdrawal of energy immaterial
8. May be constructed of many different materials. Huge unused drifts in mines have been blocked off for air receivers. During the wartime steel shortage, sunken concrete receivers were considered
9. Long lived.

To store pneumatic energy, the pressure in the receiver must rise, and conversely, to give up energy, the pressure must drop. The amount of work obtained by using air from a receiver in different ways is shown in *Fig.* 14. The initial receiver pressure is 500 psi and a pressure-reducing valve is used to maintain the desired downstream pressure to the motor or motors. If the compressed air is withdrawn from the vessel very rapidly, the air cools from expansion, but little heat can be picked up from the surrounding vessel or atmosphere because of the short duration, so the expansion is adiabatic. On the other extreme, the compressed air may be withdrawn so slowly that it remains at approximately the same temperature by picking up heat from its surroundings, so the expansion is isothermal.

Again it is impossible to meet either of the preceding situations but, because most pressure drops are rapid and

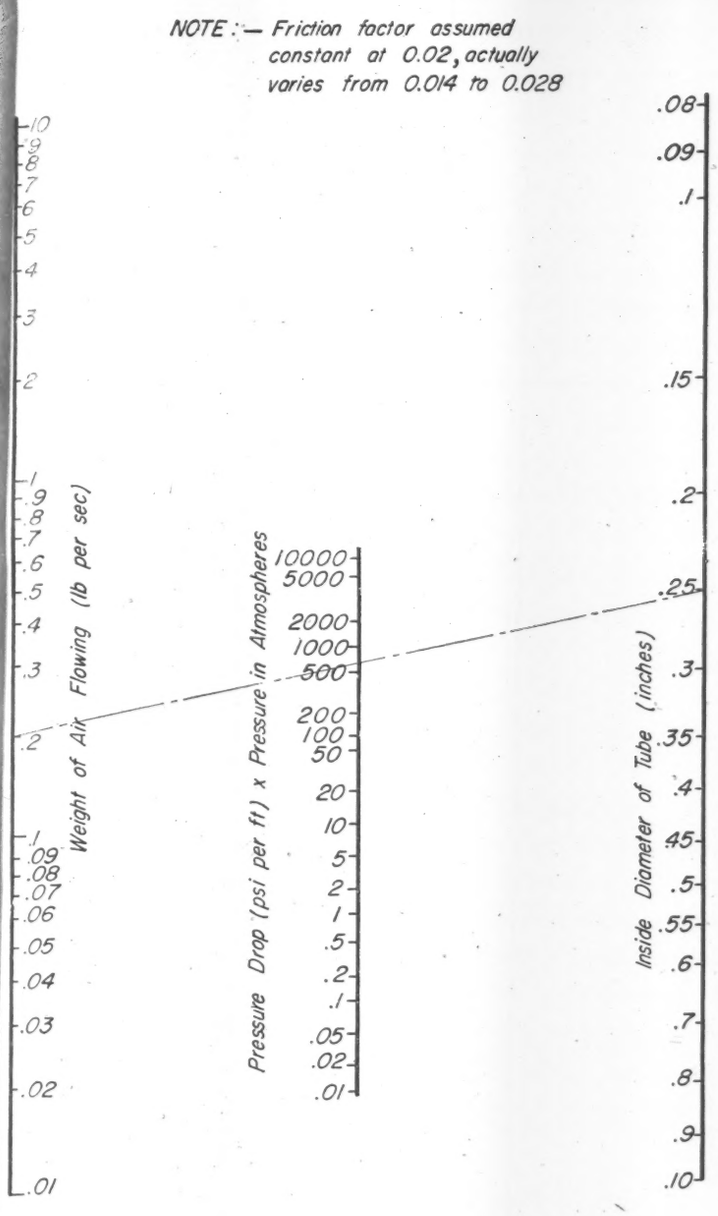


Fig. 16—Above—Nomograph showing pressure drop of air in small, drawn tubes

because it is conservative, adiabatic expansion should be used in design calculations. Hence, curves 1 and 2 in *Fig.* 14 apply in most cases. These curves all reach a peak at one-fourth to one-third initial pressure because of atmospheric back pressure, i.e., the expanding air must work against atmospheric pressure as well as the load and at low operating pressures this becomes important. If the air were expanding into a vacuum, all three curves would asymptotically approach the *Y* axis. Obviously then, to obtain the maximum energy from a receiver, the operating pressure must be well below the peak receiver pressure.

The receiver may be used as an aftercooler in small systems, and in systems where the flow through the receiver in relation to the receiver size is not too high, oil and water separation may be effected. Too, pulsations from a reciprocating compressor or other sources may be damped by a receiver. For this very reason compressor-regulation air in a pneumatic system is taken from the receiver and not from the compressor discharge line direct.

Transmission of Compressed Air: Because of its compressibility, the flow of air in a tube differs considerably from the flow of fluids. Friction between the air and the tube walls not only causes pressure drop but causes heating of the air. For a given mass flow this means an increase in volume as the air proceeds down the tube which aggravates the situation so the pressure drop in the next section is even more. Fortunately, however, the friction losses are low compared to fluids. Approximate pressure drop in clean, steel pipe is shown in *Fig.* 15 and the loss in small drawn tubes in *Fig.* 16. Data available on the flow of air in clean, drawn tubes are meager and *Fig.* 16 should be treated as approximate. No corrections for line fittings have been made in these charts.

When installing piping or tubing, it should be remembered that this too acts as an air receiver and aftercooler, so oil and water may collect in the piping, especially if it is not effectively removed previously. The piping should have some slope to insure drainage, particularly for long runs, and all low spots should have a "leg" to collect

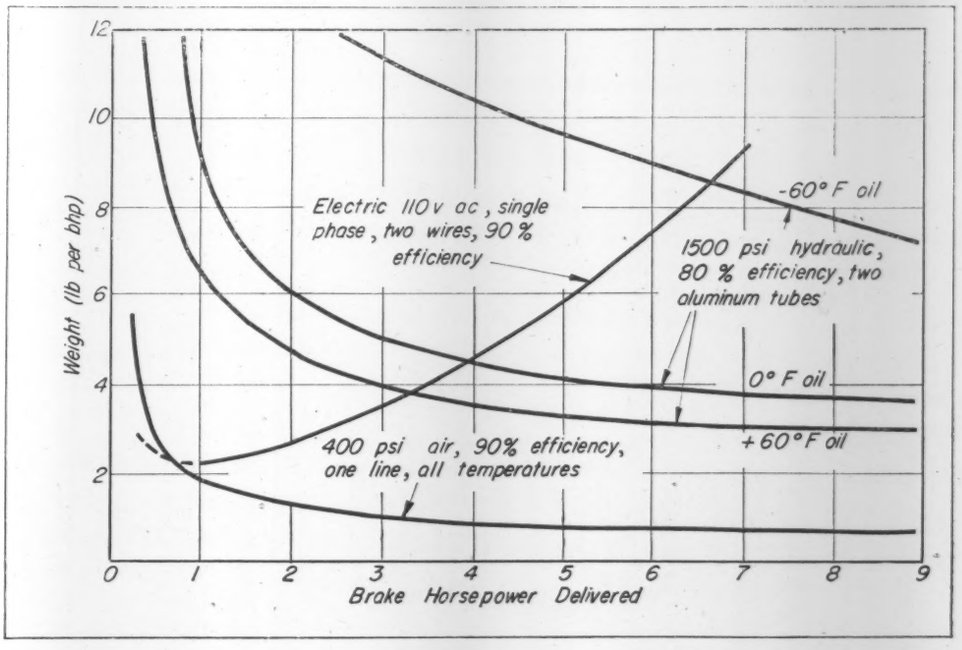


Fig. 17—Right—Weight comparison for different methods of transmitting power based on a 50-ft transmission distance, weight including wire and insulation or aluminum tubing and fluid

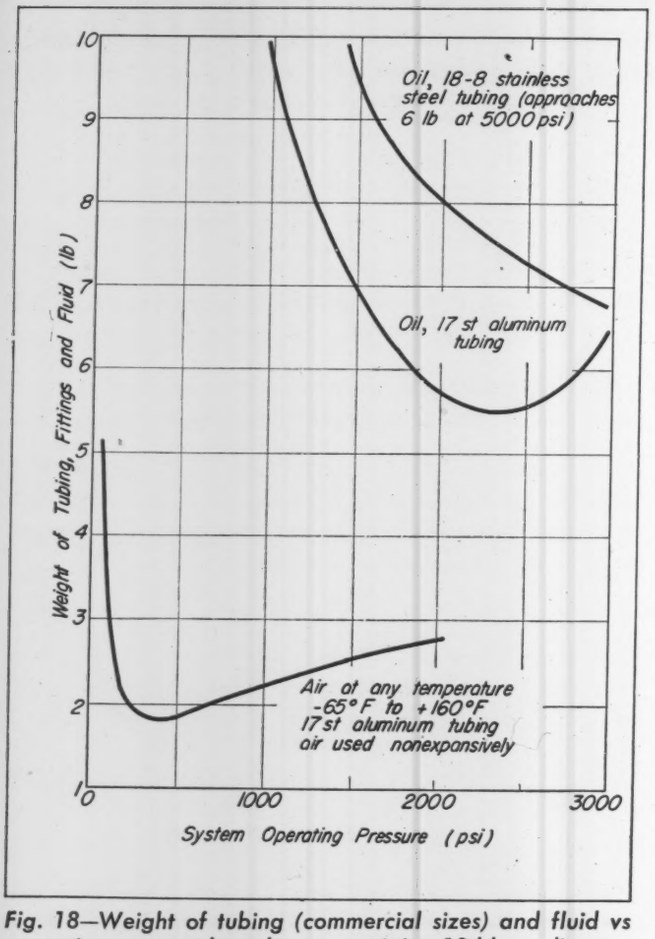
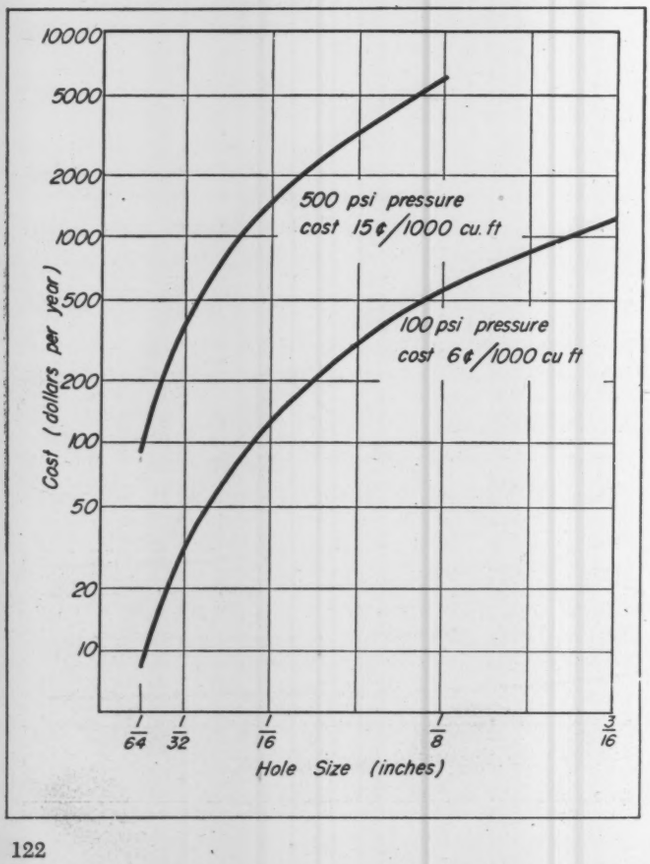


Fig. 18—Weight of tubing (commercial sizes) and fluid vs operating pressure based on transmitting 10 bhp a distance of 50 feet at 97 per cent efficiency

Fig. 19—Approximate annual cost of supplying compressed air to a leak assuming a flow coefficient of 0.65



liquids. Automatic traps may be provided. If this drain is not provided, unused line extensions may collect a considerable volume of water while standing which, necessarily, must be blown out before the air can be used.

In *Fig.* 17 is given a transmission-weight comparison between electric, hydraulic, and pneumatic systems. It should be noted that 400 psi air pressure is used, as it is the minimum weight point for compressed air as indicated by the plot in *Fig.* 18. Here again is emphasized the fact that it is unnecessary to use high operating air pressures to obtain minimum weight.

Effective Sealing Extremely Important

SEALING PROBLEMS: Because it is a gas, compressed air will escape where fluids would be retained, and since air has no lubricating qualities, sliding seals must be carefully treated. In *Fig.* 10 was indicated the amount of air power that can escape through a small hole as compared to hydraulic fluid so the need for effective seals can be readily recognized as doubly important. In industrial service where pressures are low and considerable compressor capacity is installed, small leaks are not serious, but in systems where the compressed air is held in the receiver over extended periods without compressor operation or where the system is extensive but the compressor capacity small and the operating pressure high, leaks can become serious because they reduce the power *available.* In any case, a leak is a direct loss of efficiency and costs money. The approximate cost of supplying compressed air to a specified leak continuously is shown in *Fig.* 19.

Types of seals for air-operated mechanisms may be divided into the following classifications:

1. Static seals
   a. Perfect permanent seals with no permissible leak
   b. Refined seal—small leak permissible
2. Dynamic seals—sliding, rotating, or linear movement
   a. Perfect seals with no permissible leak
   b. Refined seal—small leak permissible.

Most types of sealing elements used with fluids are suitable for compressed air, but some require special provisions for lubrication. Seals used most frequently are listed together with their position in the preceding classification:

1. Tapered pipe thread—1b
2. Flat soft face seal—1a
3. Sheet gasket material—1a
4. Leather packing (may be with garter spring) 1b or 2b
5. "O" rings—with or without backup rings for higher pressures—1a or 2b
6. Asbestos ring type packing—2b
7. Semi-metallic type piston rod packing—2b
8. Metallic segmented rings—2b
9. Piston rings—metallic—2b
10. Bellows—2a
11. Diaphragm—1a
12. Fluid seal—1a or 2a
13. Carbon shaft seal—2b

In the third part of this series of articles which will appear in the June issue of MACHINE DESIGN, the author will cover power uses of compressed air, discussing cylinders, motors, and turbines and their characteristics along with typical problems in design.

Fatigue-Testing Machine

. . . employs ingenious inertia compensator to insure constancy of the repeated applied force

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IT IS now generally recognized that intelligent fatigue testing is one of the most effective means of evaluating service performance of materials, joints, subassemblies, and complete units. However, a fatigue test must satisfy certain requirements before it can be considered a valid index to serviceability—just breaking specimens or structures by vibrations is not sufficient. A critical analysis of the various types of fatigue-testing machines is therefore a necessary first step in any fatigue-testing program. Fatigue tests are of two main types, briefly described as follows:

a. Specimen testing—the testing of carefully prepared specimens under simplified conditions of stress and environment for the purpose of securing what may be considered basic material properties
b. Simulated service tests—the testing of actual parts, shapes, assemblies, or structures under conditions which closely simulate actual service to secure direct design data.

If service conditions and the basic material properties are accurately known, it should usually be possible to predict the behavior of a structure in service, and reasonable success has been achieved in the case of static loads. However, prediction of behavior under dynamic loads, from the basic properties of the constituent materials, is risky due to such difficult variables as stress concentration, stress distribution and redistribution, natural frequencies, damping, etc. Experience indicates that, at present, the best procedure is to use specimen testing as a guide to the selection of materials and as an aid during the initial design stages, but to rely on the simulated service test to refine a design and to check actual serviceability. Although no test of serviceability is as foolproof as actual service, to rely exclusively on actual service is usually impractical, time-consuming, and expensive, hence the simulated service test is a vital link in modern engineering analyses.

Hitherto, most fatigue machines have been of the special-purpose type, and a need has long existed for a universal machine which would meet the following requirements:

I. Ability to impose, with suitable fixtures, any of the three basic types of simple stress—tension-compression, bending, or torsion. Such a wide range of testing requires a machine with large permissible stroke.

II. Ability to apply a static preload upon which may

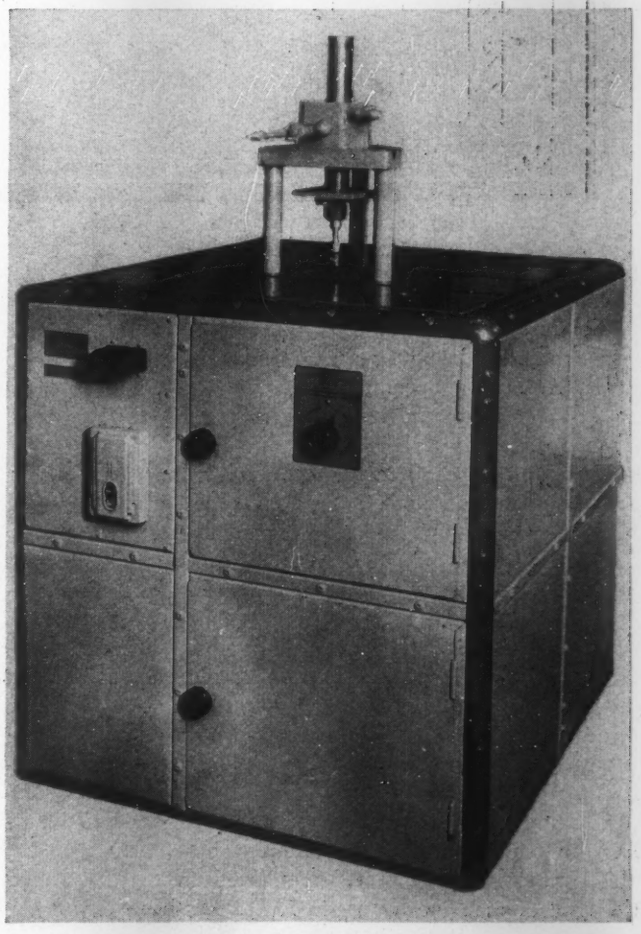

Fig. 1—New below-resonance, centrifugal force type fatigue-testing machine with inertia force compensator, shown with tension-compression fixture attached

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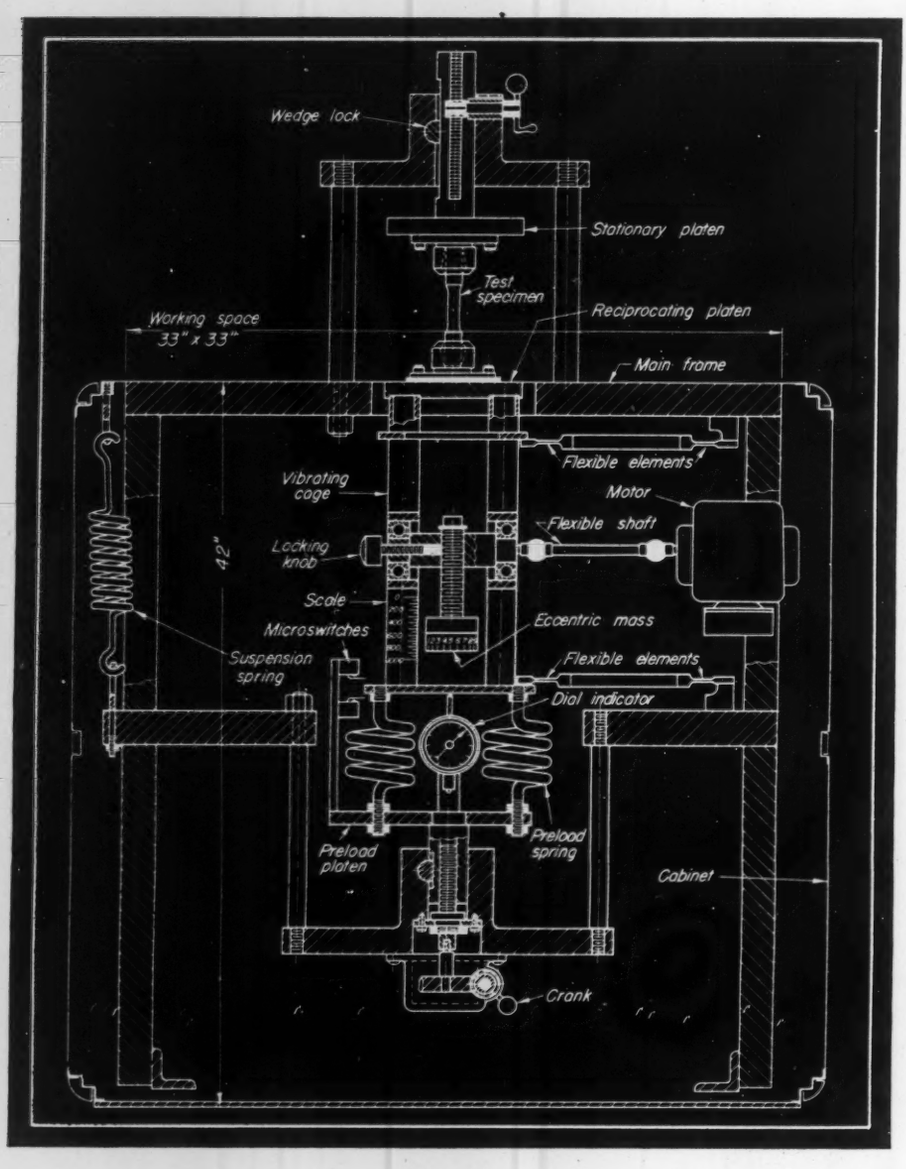
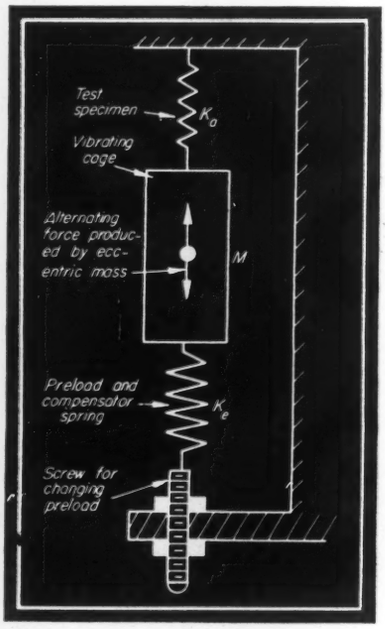


Fig. 2—Left—Schematic cross section of the machine, showing means for applying the static and variable components of the test loading

Fig. 3—Below—Single degree of freedom vibrating system of machine. With compensator spring, the force on the specimen is independent of the amplitude of vibration



be superimposed an alternating force so that nonreversing force conditions may be investigated. This permits testing under a stress range which duplicates service and also enables securing complete Goodman diagrams.

III. Ability to accommodate, with suitable fixtures, either carefully prepared test specimens or actual parts or structures.

IV. Ability to impose a repeated constant *force* rather than repeated constant *deflection*, since parts in actual service are usually subjected to a repeated force and the deflection is only incidental. It has been accepted practice when using a repeated constant-deflection machine, such as the crank type, to stop the machine periodically, check the force, and adjust the deflection accordingly. This procedure is not only time-consuming but may also produce erroneous results due to variable force history and possible effects of rest periods, hence the repeated constant-force type of machine offers definite advantages.

V. Simplicity, foolproof operation and ease of handling by one relatively inexperienced operator.

To meet the requirements outlined in the foregoing, the type of machine shown in *Fig.* 1 has been developed by the Sonntag Scientific Corp., Greenwich, Conn., and is now made in two sizes by the Baldwin-Southwark Div. of Baldwin Locomotive Works, Philadelphia. The machine is known as a below-resonance, centrifugal-force type with inertia force compensation. Schematic diagrams of the vibrating system are shown in *Figs.* 2 and 3. Source of the alternating force is a single, eccentrically supported mass driven by a synchronous electric motor through a flexible shaft. This rotating eccentric is supported within a cage which is guided by a flex-plate system having sufficient distance between flexible elements to make the arc of motion of the cage negligibly small. This guide system not only insures vertical translational motion of the cage but also absorbs the horizontal component of the centrifugal force of the eccentric. Compensator and preload springs are secured between the bottom of the cage and an adjustable preload plate.

Holding fixtures and grips for the specimens or structures are attached between the top of the cage and the main frame. For example, with the direct-stress fixture shown in *Fig.* 1, the test specimen is subjected to alternating tension-compression when held between the stationary platen and the reciprocating platen. When the

specimen breaks, microswitches shut off the machine and the number of cycles to failure can be read on a counter at any time thereafter. The entire frame is seismically suspended in a cabinet by springs so that no vibrations are transmitted to the floor.

The calibrated screw-type eccentric mass may be adjusted to any position and locked by a knob. Force output of the eccentric is accurately known from the following equation:

$$(P = KUf^2)$$

where P = plus-minus alternating force, U = unbalance of eccentric in in-lb, f = speed of rotation of eccentric or motor, and K = constant. Since the speed of the motor is constant and known for any given machine, force of the eccentric depends only on the unbalance. The force output in pounds is read directly on the adjacent scale and around the eccentric like a micrometer.

Provision is made for applying a static preload through springs. As the preload platen is moved up or down with a worm and screw drive, a static force is built up in the specimen equal to the force in the flexible preload springs, which are accurately calibrated. This force is determined from a dial indicator and calibration chart.

Another important function of the preload springs is to absorb the unknown inertia force produced by the vibratory motion of the cage and attached parts such as grips. In order to clarify this statement, *Fig.* 3 shows schematically the vibrating system used in the fatigue machine. If the preload and compensator spring is omitted, the alternating force in the specimen equals the vector sum of two quantities: (a) The centrifugal force output of the revolving eccentric and (b) the inertia force produced by the vibrations of the effective mass of the cage, grips, and attached parts.

Quantity (a) is generally easy to adjust and control by simply controlling the unbalance in the eccentric and the frequency. Quantity (b), however, depends on amplitude of vibration (which is affected by stiffness of specimen, machine, etc.) and phase angle, both of which are subject to change during the test and difficult to control. For this reason, previous centrifugal-force type fatigue machines (1)† not employing inertia-force compensators or automatic controllers could be used only for stiff specimens, when quantity (b) was negligibly small due to the small amplitude of vibration. For flexible specimens where near-resonant vibrations may occur, factor (b) may be many times larger than factor (a) in the system without the compensator spring. This limitation is overcome in the present machine by designing the preload springs with such a stiffness (see proof in the Appendix) that its force during the vibrations is always equal and opposite to the inertia force, factor (b). Thus, the force in the test specimen is always equal to the force output of the eccentric, irrespective of amplitude of vibration. This results in an automatic self-adjusting system in which the amplitude of vibration immediately increases whenever the stiffness of the specimen changes during the test due to looseness, heating, cracks, change in modulus of elasticity, etc.

The top of the machine is provided with T-slots and tapped holes so that a variety of loading fixtures may be easily attached. In the direct-stress (tension-compression) fixture shown in *Figs.* 1 and 2, the stationary platen may be adjusted vertically with a rack and pinion adjuster and secured in the desired position by a wedge lock. Several different types of specimen grips have been used such as the friction-type, collet-chuck grips shown in *Figs.* 1 and 2, and spherical grips specially designed to insure concentric loading.

Bending fixture shown in *Fig.* 4 imposes a repeated

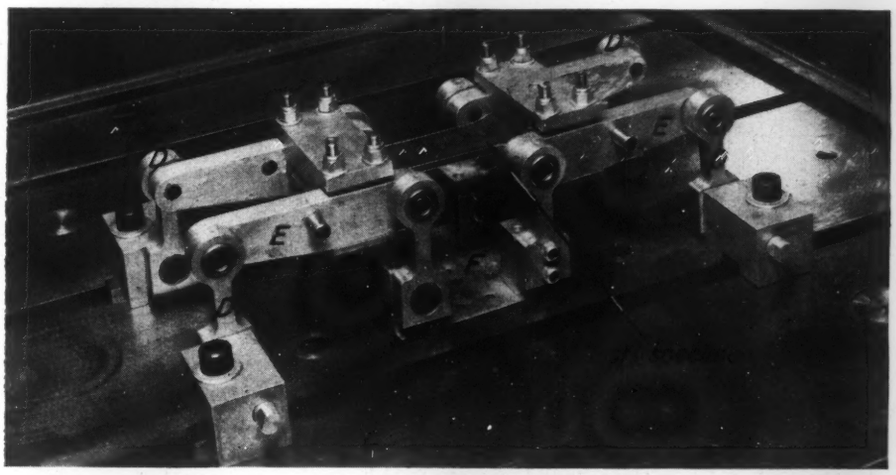
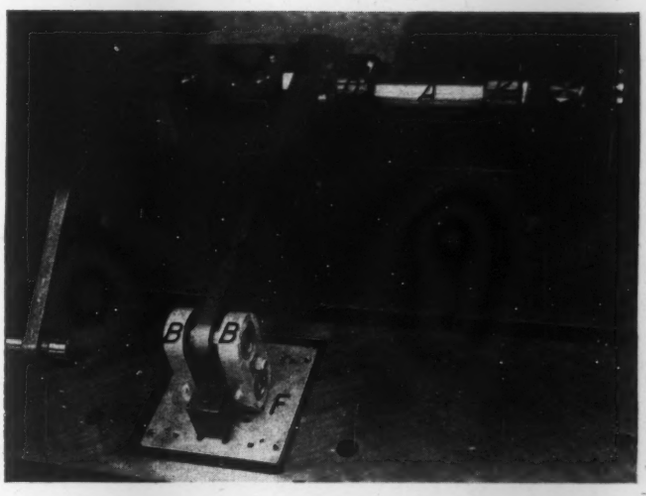


Fig. 4—Left—Fixture for applying repeated bending load to specimen A

Fig. 5—Below—Torsion fixture for fatigue machine. Combined bending and torsion result if the fixed support E is omitted



† Numbers in parentheses refer to references at end of article.

constant bending moment over the full exposed length of the test specimen. Needle-bearing loading arms transmit, without binding, the force from reciprocating platen *F* to loading cradles *E*. Arms *D* anchor the rear end of the cradles to the stationary top *C* of the fatigue machine. This fixture is designed so that it may be rearranged to accommodate test specimens of different lengths.

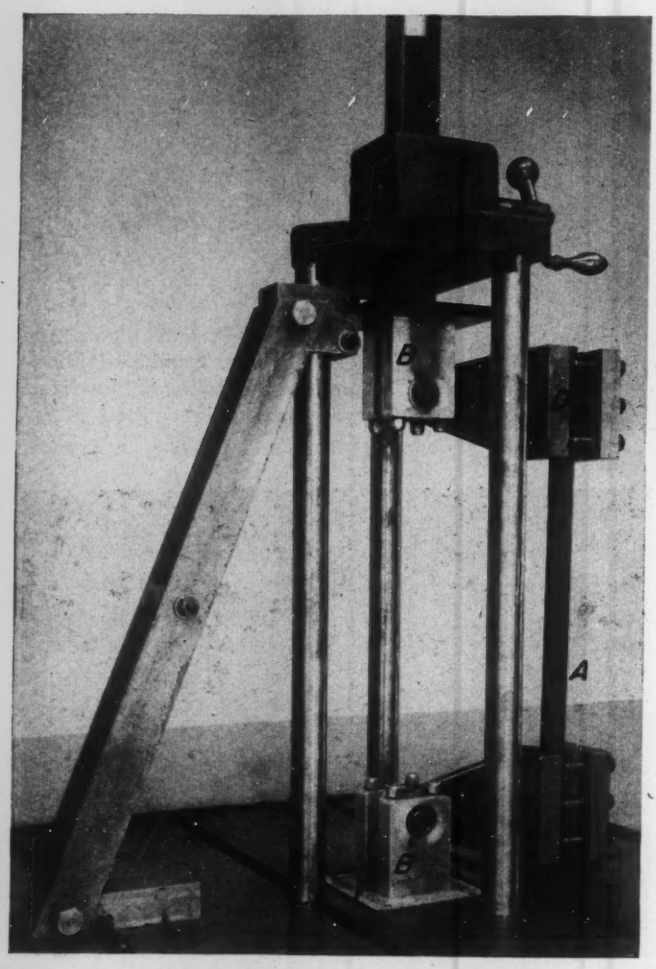
In the torsion fixture shown in *Fig.* 5 the alternating force is transmitted from platen *F* to crank arm *H* by needle-bearing arms *B*. Thus an alternating torsion is produced at chuck *D* which is supported in bearings in block *E*. Specimen *A*, loaded torsionally by chuck *D*, is rigidly held at its right end by chuck *K* which is locked in block *G*. Block *G* may be moved in the T-slot shown to accommodate different lengths of test specimens. A shorter crank arm *H'* may be used, with blocks *E* and *G* in the middle T-slot, for tests requiring larger stroke but smaller torque.

The torsion fixture of *Fig.* 5 may also be used to test materials or manufactured units under combined torsion and bending. If bearing block *E* is removed from the fixture, the specimen *A* will be subjected to a torsional force dependent on the length of crank arm *H*, and also a bending force dependent upon the distance between the crank arm and the test section in specimen *A*.

A further example of what can be done with combined-stress fixtures is illustrated in *Fig.* 6. Specimen *A* is a hexagonal rod in which service failures in fatigue are rather common. This rod receives a combination of repeated bending and repeated direct stress in service and the fixture is designed to simulate this condition. Specimen *A* is held by gripping arms *D* which pivot freely on needle-bearing fulcrums *B*. Thus as platen *F* vibrates vertically the specimen receives the direct force of the platen plus a bending force dependent on the distance between the fulcrums *B* and the specimen. Any ratio of direct force to bending force may be obtained by adjusting the length of gripping arms *D*. This particular test was devised to investigate different types of heat treatments, surface treatments such as shotpeening, and composition changes.

A set-up for testing a wrist pin and connecting members in a piston and connecting rod assembly is shown in *Fig.* 7. By adjusting the tension-compression preload and alternating force the desired condition of axial vibration may be induced in the assembly so that weak points may be located. Such tests lead to improvements in shape, fillets, materials, heat and surface treatment, etc., which result in a better product. Such fatigue testing of assemblies is essential since it is practically impossible to analyze theoretically or photo-elastically the three-dimensional state of stress involved. Furthermore, such variables as surface condition of the part due to the fabrication method and the notch sensitivity of the surface metal make an entirely theoretical approach almost hopeless.

Fig. 6—Fixture for fatigue machine designed to produce combined bending and direct stress in specimen A



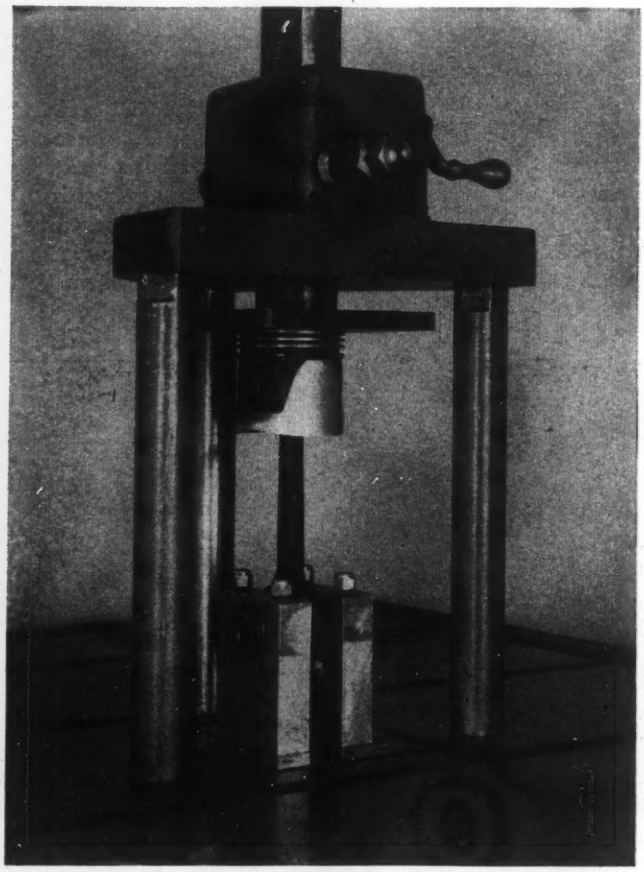


Fig. 7—Tension-compression fixture set up to test piston and connecting rod assembly in fatigue

As already mentioned, one of the important features of the machine is that it imposes a repeated constant force on a test specimen instead of a repeated constant deflection. The significance of this feature is apparent from test data obtained with the machine. In *Fig.* 8, for example, a decided decrease (over 40 per cent) in specimen stiffness may be caused by sustained cyclic stress. If a crank-type, repeated constant-deflection machine had been used this decrease in stiffness would appear as a proportional reduction in force on the specimen. Thus, unless frequent readjustments of deflection are made, the specimen would be subjected to a variable stress history and accurate results could not be expected.

For steel and other strong ferrous metals the change in stiffness is generally considerably smaller than for the weaker nonferrous metals (2) (3) (4). On the other hand, for plastics and other high damping materials the temperature increase caused by hysteresis often causes considerable stiffness changes (3). For built-up materials localized fragmentation is often the cause; in plywood tests, for example, sudden increases in amplitude of vibration were accompanied by audible cracking sounds. In general, the change in stiffness under sustained dynamic load is greater for a structure than for a test specimen. Any loosening of the joints, local yielding, redistribution of internal forces, etc., will generally result in substantial change in stiffness.

The author gratefully acknowledges the aid given by Messrs. A. Sonntag and A. Yorgiadis in the preparation of this article.

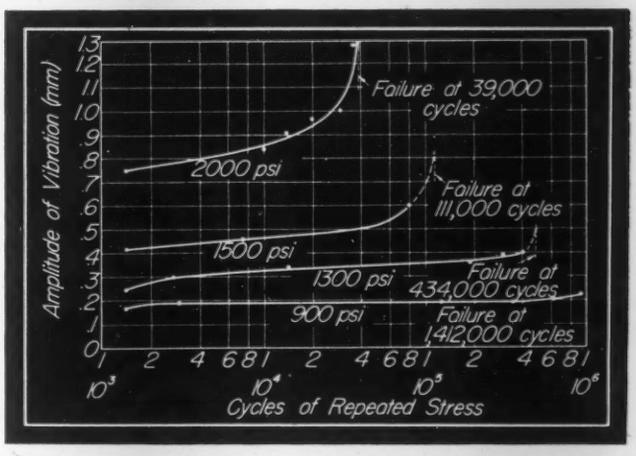


Fig. 8—Effects of sustained cyclic stress on stiffness of lead under reversed bending at 1800 cycles per min

Appendix

Inertia Force Compensator Analysis

Referring to *Fig.* 3, the vibrating oscillator mass is connected elastically between two springs: 1. The test specimen and 2. the compensator spring. Since the vibrating mass is restricted to motion in a vertical direction only, the single eccentric may be considered to produce a vertical sinusoidal force $P \sin \omega t$. Following is proof of how the compensator spring performs its function.

The equation of motion of an undamped single degree of freedom system, *Fig.* 3, under forced vibration is (5):

$$M\,(d^2x/dt^2 + (K_a + K_e)\,x = P \sin \omega t \quad \ldots\ldots (1)$$

where M = mass of cage (lb sec² per in.), x = displacement of mass M (in.), t = time (sec), K_a = spring constant of specimen (lb per in.), K_e = spring constant of compensator springs (lb per in.), P = peak value of alternating force produced by eccentric, ω = frequency of alternating force P (radians per sec), and x_o = maximum value of alternating displacement x.

The solution to Equation 1 is:

$$x = x_o \sin \omega t = P \sin \omega t/(K_a + K_e - M\omega^2)$$

Therefore

$$P = K_a x_o + K_e x_o - M\omega^2 x_o \quad \ldots\ldots (2)$$

If the compensator spring is designed to have a stiffness K_e equal, numerically, to the product $M\omega^2$, then $K_e x_o$ cancels $M\omega^2 x_o$ in Equation 2 and:

$$K_a x_o = P \quad \ldots\ldots (3)$$

Since K_a is the spring constant of the specimen and x_o is its amplitude of vibration, $K_a x_o$ equals the peak force in the specimen. Thus the peak specimen force equals the peak value P of the eccentric force, irrespective of rigidity of specimen or amplitude of vibration. Furthermore, if K_a changes during the test, the amplitude x_o will adjust itself so that the product $K_a x_o$ (the force in the specimen) is constant.

Inertia force compensation is thus complete only if the following condition is met:

$$K_e = M\omega^2 \quad \ldots\ldots (4)$$

This means that for a given mass, M, of the reciprocating cage and a given spring K_e, compensation is accurate only at one frequency ω. The fatigue machine under discussion can therefore operate at only one frequency and is for this reason driven by a synchronous motor.

From Equation 4, the operating frequency of the machine is:

$$\omega = \sqrt{K_e/M} \quad \ldots\ldots (5)$$

From this equation it is apparent (see Reference 5) that the natural frequency of the vibrating system without a specimen inserted should be equal to the operating frequency. This observation facilitates checking and calibrating the machine.

The foregoing derivation assumes the vibrating system to possess zero damping. Experience has shown that in practically every case the damping in the system is sufficiently low to make resulting errors negligible.

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Self-Winding Watches

All work on same basic principle, being wound by a swinging weight energized by motions of the wearer's arm

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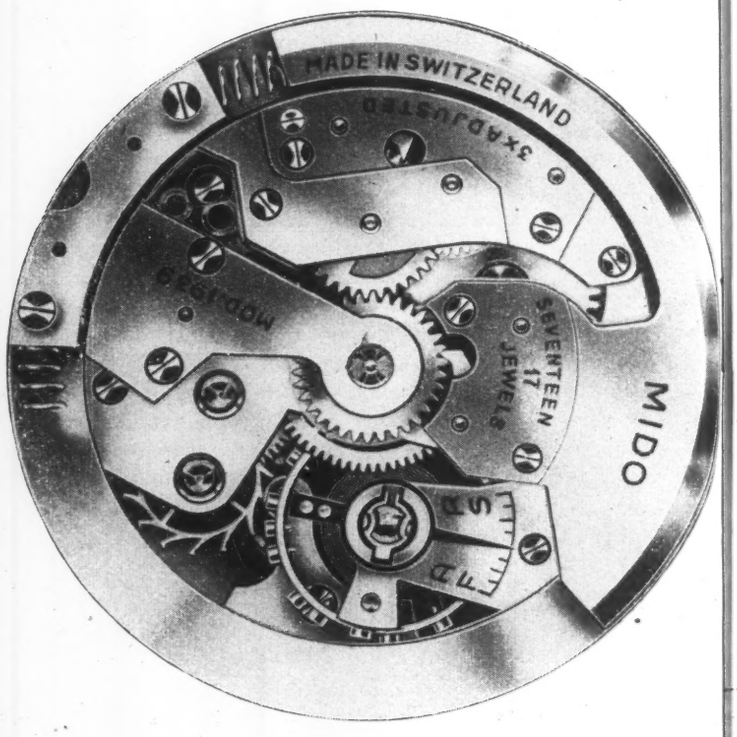


Fig. 1—Typical modern self-winding watch mechanism. Its predecessors were invented years before the button-wound watch. (Photo, courtesy Mido Watch Co. of America)

ALTHOUGH most people think of the modern self-winding or "perpetual" wrist watch, *Fig.* 1, as a comparatively new development in the horological art, it is interesting to note that the general principle of this winding mechanism was invented and used in watches before most of the other keyless devices. As early as 1700 there were a few isolated examples of watches wound by levers or other means not requiring a key, but one hundred years later these were still regarded as novelties and were not in good favor. After 1800, more and more patented keyless winders appeared, the two in current use today having been invented in 1843 and 1855 respectively. It was not until after 1870 that winding by a separate key began to be definitely displaced by the present form of crown or button which also controls the setting function previously performed by the winding key.

One of the "novelty" watches mentioned as existing around 1800 was a self-winding pocket watch. Abraham Louis Breguet, a famous French watchmaker with many ingenious (and theoretically correct) inventions in the horological field to his credit, is generally conceded to have invented this winding mechanism about 1790, although there is some evidence of a previous disclosure by Recordon ten years earlier. Napoleon I, emperor of France from 1804 to 1815, owned such a watch, which when carried upright in a pocket was wound by up-and-down motions of the wearer as he moved about. In principle the winding action of this watch was similar to the mechanism of a pedometer, a watch-shaped device carried in the pocket to record mileage traveled on foot. It is illustrated diagrammatically in *Fig.* 2, which for clarity is drawn with the parts rearranged from their positions in the actual watch.

With reference to the figure, the weighted lever is fixed to its arbor and counterbalanced (when in the position shown, with the watch upright) by the spiral hairspring. Although this spring obeys Hooke's law as to variation in torque with angular displacement, the arc used over the travel of the lever is so small compared to the total usable arc that the spring torque is essentially constant and the lever will be counterbalanced at any position it may assume. Another reason for using the spiral spring is that the required torque may be accurately set by either turning the collet on the arbor or by varying the pinning point at the stud end. The lever is limited to a reasonable travel by the banking springs, which provide a shock-absorbing stop at each end. Carried by this lever is a small pawl, which is kept in engagement with the ratchet wheel by a light spring (not shown). Another pawl prevents the ratchet from turning backward under the mainspring torque. The ratchet wheel is keyed to the first pinion of the winding train, yet is free to revolve on the lever arbor. Thus, as the watch is jounced up and down vertically due to motions of its wearer, the inertia of the weighted lever will tend to keep it from moving suddenly, and the relative motion so produced about the axis of the lever arbor will cause the driving pawl alternately to turn the ratchet wheel and slide back for a new grip on its teeth. From this point to the winding arbor of the mainspring is a train of gears and pinions which serves to multiply the small torque available at the ratchet sufficiently to overcome that of the mainspring at its fully-wound condition.

Before considering the more modern forms of this early self-winding watch, it will be well to answer one question

which is sure to arise: What prevents a broken or at least overwound mainspring when the wearer of the watch is more active than necessary to wind it fully? There are two systems which will serve this purpose. When a conventional mainspring, hooked at one end to the winding arbor and at the other to the barrel carrying the main wheel of the watch train, is used, the pawl on the weighted lever can be made of a looped leaf spring as in *Fig.* 3, having a guide to prevent it from straightening out too far. Its tension against this guide is sufficient to advance the ratchet until the mainspring is fully wound, but when that condition occurs, further oscillation of the lever only flexes the loop until more winding is needed. Incidentally, the looped spring also is capable of outward motion during the back-slide part of the oscillation when it must snap over the teeth on the ratchet wheel for a new grip.

Slip-Spring Prevents Overwinding

Another and more usual system has the added feature of overwind prevention when the watch is provided with a conventional winding stem and crown in addition to its self-winding parts. This is a construction of the mainspring itself, which in horology is known as a "slip-spring". Instead of having the mainspring hooked direct onto the inside of the barrel, a brace, formed of one or more layers of mainspring stock, is riveted to the end of the spring as shown in *Fig.* 4. In some forms of slip-spring, the brace is fastened so as to follow the outer coil of the spring and strengthen its friction on the inside wall of the barrel as shown at (a). Other forms have the brace reversed similar to that drawn at (b). Either style may provide still greater resistance to slippage by having a bump formed into the brace to co-operate with notches in the barrel wall. Type (a) usually requires a multi-layered brace because, as the spring is wound tighter about the center arbor, the pull on the rivet tends to greatly decrease the area of sliding surface against the barrel wall, whereas the brace shown at (b) will expand against the wall with increased pull, except in the immediate vicinity of the rivet. It is perhaps superfluous to add that either type must be well lubricated to insure a nearly constant coefficient of friction, so that the friction drag will be controlled by the normal force exerted on the barrel by the brace.

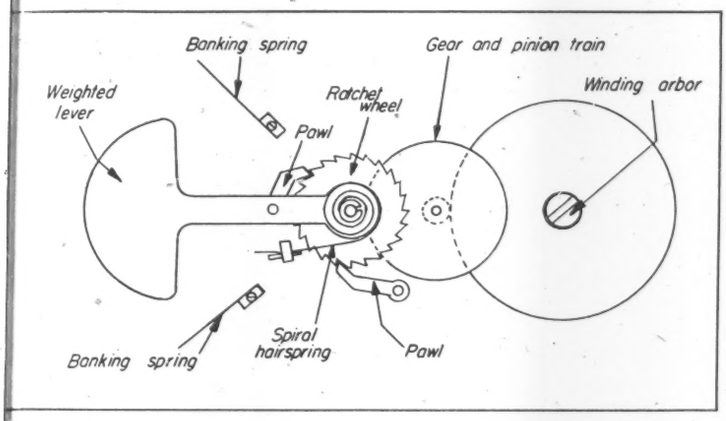


Fig. 2—Elements of self-winding mechanism. Weighted lever swings in response to wearer's arm motions, driving the ratchet wheel by means of a pawl

At the present time there are no self-winding pocket watches being manufactured. This is due partly to the currently great popularity of the wrist watch, and partly to the fact that the pocket watches which are sold today are either dress watches which are too thin to permit the addition of a self-winder, or utility watches, the primary function of which is dependable timekeeping with no call for added complications.

While the self-winding wrist watch remains in basic principle the same as the pedometer type already described, there is one consideration related to its use which has necessitated a change in the action of the weighted lever. Wrist watches are as likely to be subjected to a rotary motion about their center arbors as they are to experience translatory motion and, furthermore, the latter cannot be depended upon to occur in one direction or even in one plane. Hence it is quite universal in automatically wound wrist watches to pivot the weighted lever in the center of the movement and not provide any counterbalancing spring. Thus, rotary motion in one direction winds the watch, and in the other direction brings the click back to a new grip on the ratchet-wheel teeth. Furthermore, translatory motion in the plane of the movement usually will produce some effect upon the weighted lever.

Self-Winders Likely To Keep Better Time

Most present-day automatics, as they are called, are so designed that average motions during wearing will fully wind them in three to six hours for a run of thirty-two or more hours without being in motion. Since they are, therefore, fully wound during most of their normal life, such watches are likely to keep better time (all other conditions being the same) than wrist watches which are wound manually only once a day, because when the mainspring torque of a watch remains essentially constant, the arc traveled by the balance wheel during its oscillations will be nearly constant also, eliminating one of the causes of variation in rate.

Drawn from a photograph, *Fig.* 5 shows an actual self-winding watch movement which was chosen because when completely assembled the parts are displayed with good clarity. The entire winding mechanism is mounted on the back of the regular watch movement as a sort of

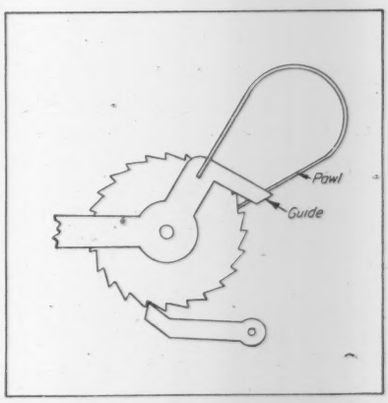


Fig. 3—One method of preventing over-winding the main spring. Looped leaf spring serves as pawl for driving the ratchet wheel

subassembly which can be completely removed by taking out relatively few screws, thus leaving the conventional parts of the movement accessible in the usual fashion. Not many alterations are required to adapt the self-winder to a watch already in production; a few additional screw and pivot holes and recesses in the regular bridges will do the trick. For a given size of watch case, however, a smaller movement is required for automatic winding, and this is perhaps the one disadvantage of these watches because the accuracy of parts in a larger movement is obviously greater than that of small parts. Hence, assuming the same care and workmanship, a large movement is generally more likely to be a better timekeeper than a small one.

How Typical Self-Winder Operates

In the design shown in *Fig.* 5, the weighted lever (called the "hammer" due to its shape and its action on the banking springs) oscillates about a pivot in the center of the watch, carried in the bridge screwed to that over the small train and escape wheels. Also carried on this central pivot is a wheel, which serves a dual function in that it is driven as a ratchet wheel by the hammer pawl when the hammer turns counterclockwise, and also transmits the motion as a gear to wheel *A* in the winding train. Reverse or unwinding motion is prevented by the pawl which engages the teeth of wheel *A*. From this point the winding train consists of a pinion under wheel *A* driving wheel *B*, which in turn has a pinion driving the main winding wheel. This wheel is mounted on the spring barrel arbor and in turning winds the mainspring from the center in the ordinary fashion. To complete the assembly, the two banking springs which limit the travel of the hammer and prevent the shock of its reaching a stop may be clearly seen mounted into a block which is screwed direct onto the movement holder ring.

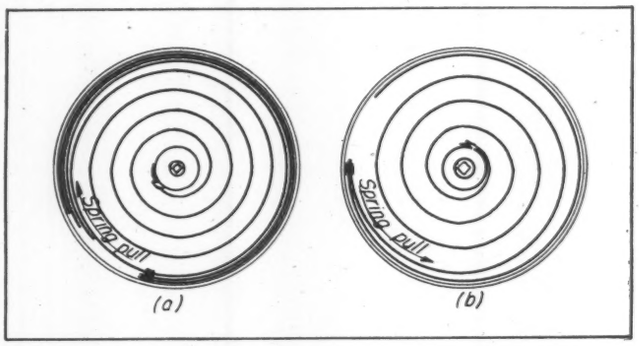


Fig. 4—Above—Preventing overwinding in mainspring itself. Brace, fastened to outer coils, rubs along inside wall of barrel where it creates sufficient friction to permit spring windup, but slips if excessive torque is applied to spring. Arangements shown at (a) and (b) are simliar, but operate in opposite directions

All other automatic wrist watches are but variations of the one just described, the differences involving only changes in positions and shapes of parts, and methods of attachment of the parts to the basic movement. At present all of these watches are Swiss-made, those used in the United States being imported.

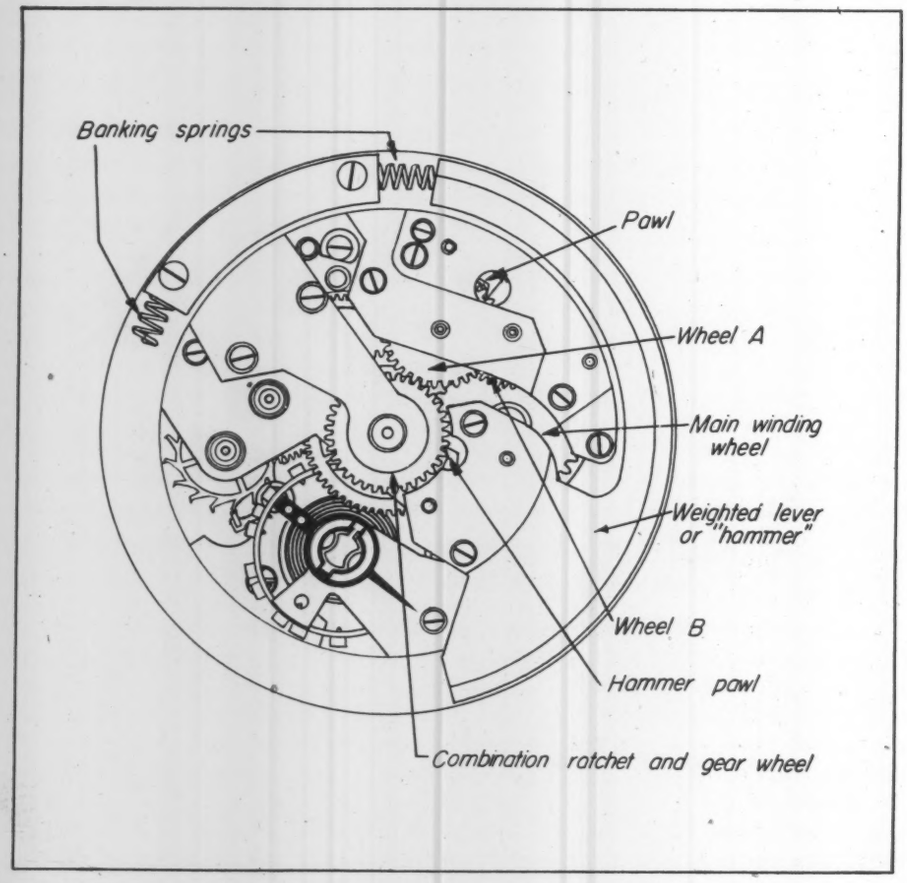
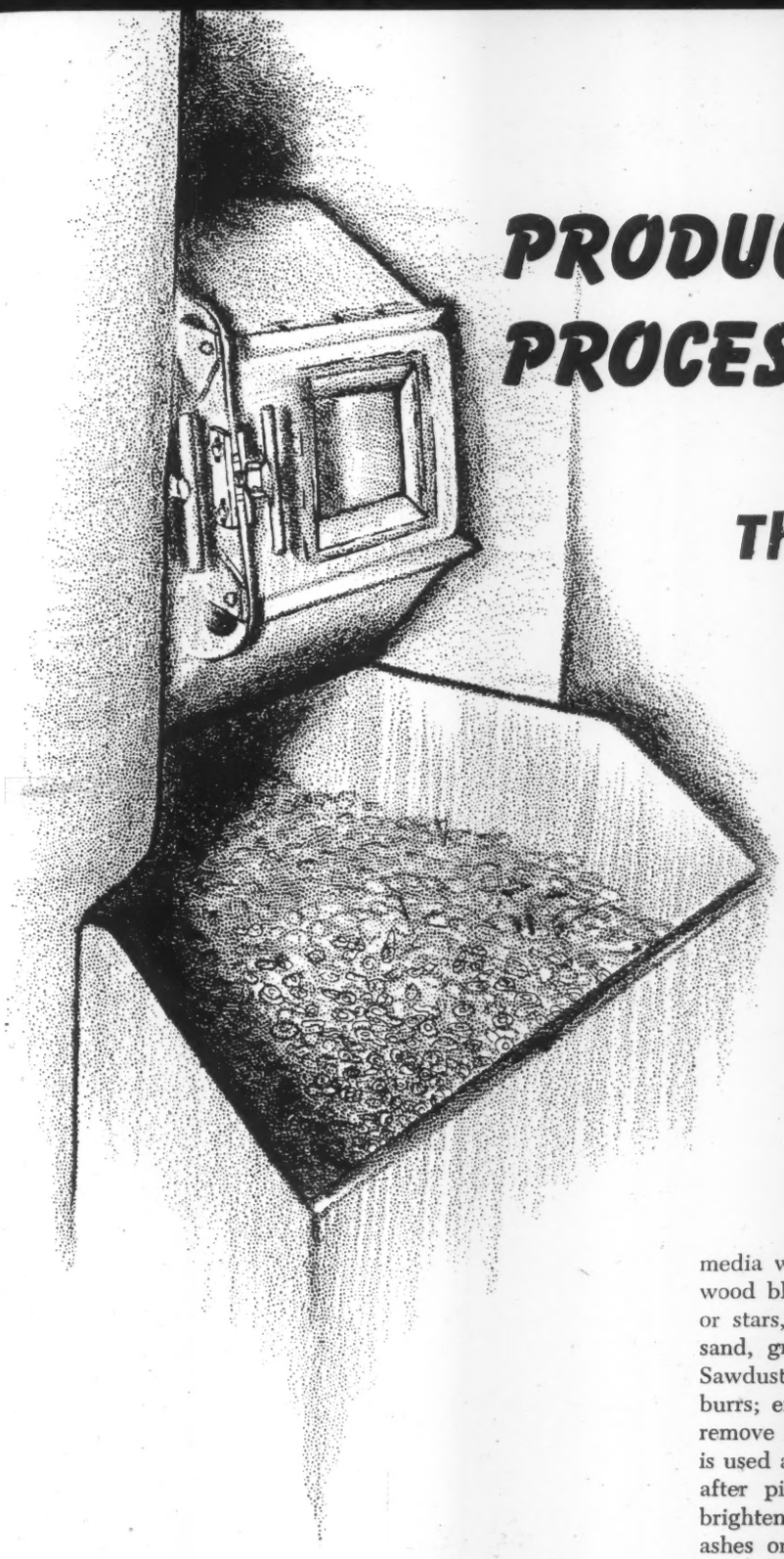


Fig. 5—Left—Self-winding mechanism is mounted on back of conventional watch as a subassembly. Banking springs eliminate shock as "hammer" swings back and forth about the watch center



PRODUCTION PROCESSES...

Their Influence On Design

Part XXIII–Barrel Finishing

By Roger W. Bolz
Associate Editor, Machine Design

RECENT developments and experience in the field of barrel finishing have made practicable, if not highly desirable in many cases, the use of this process in the precision finishing of machine parts. Especially well adapted to mass production work, *Fig.* 1, barrel finishing requires considerably less time and results in surfaces far superior to those usually obtained with hand-finishing methods commonly used.

In general, tumbling barrels have been widely used to remove burrs, fins, flash, scale, roughness, rust, oil, grease, sand, and dirt on parts of such materials as steel, cast iron, aluminum, brass, plastics, etc. Some of the common media which have been used in tumbling are: Sawdust, wood blocks, leather scraps, meal, steel balls, slugs, jacks or stars, emery, ashes, pumice, Vienna lime, white silica sand, gravel, sulphuric acid, soda, cyanide, and potash. Sawdust and steel slugs are used to absorb oil and remove burrs; emery and white silica sand or gravel are used to remove flash from brass and steel stampings; sawdust is used alone to remove grease, rust and scale, to dry work after pickling and plating, and to c l e a n as well as brighten brass and other nonferrous parts; fine sand, ashes or Vienna lime, and steel balls are used to clean and rough-polish pawls, studs and similar small parts; sulphuric acid and water or water and egg of cyanide are used to remove scale and roughness and to clean various parts; maple blocks and sawdust are used to remove flash and polish plastic parts. Most interesting perhaps, dry ice chips are used with great success for removing the flash from a variety of molded-rubber machine parts. The chips serve both to quick freeze the thin flash and also tumble it off smoothly.

Though these and other similar tumbling techniques are widely employed to advantage in the processing of large quantities of parts, the latest phase of importance to the machine designer is that in which specially prepared

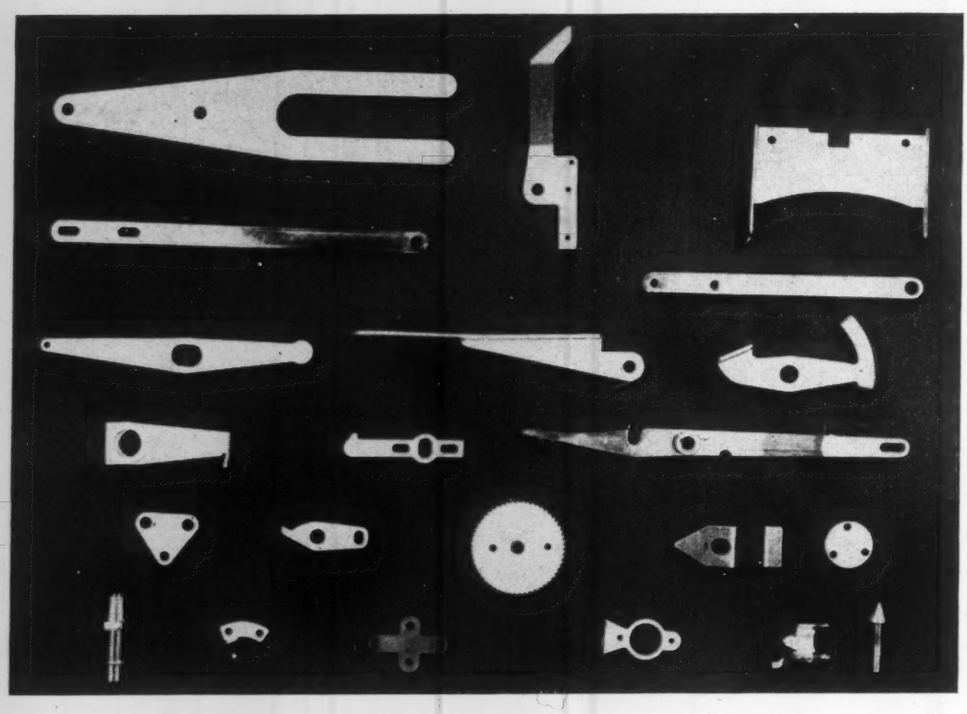
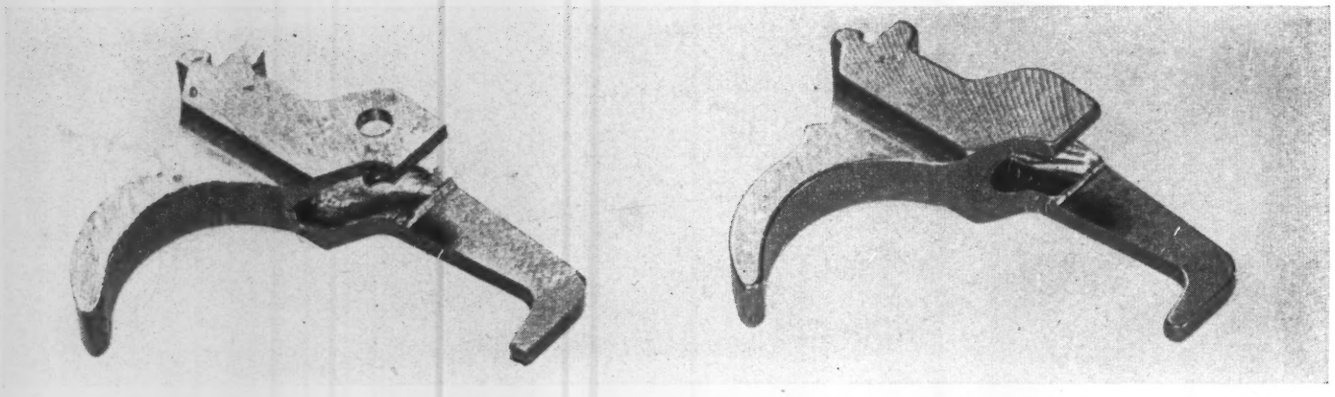


Fig. 1—Left—A few of the many precision machine parts employed in the Capehart record changing mechanism which are barrel finished in large quantities

Fig. 2 — Below — Removal of burrs and metal fragments left from machining this steel trigger cost only $0.0006 per piece, a saving of 95 per cent over previous low production hand methods



abrasives are employed to provide precisely controlled results not available heretofore.

This particular phase of barrel finishing, sometimes referred to as rotofinishing, is basically a mechanical grinding and honing process which depends upon the free-mass abrasive action of special abrasive compounds, quartzite or manufactured abrasive chips, stones or pebbles under agitated rotary actuation. Processing may be carried out either dry or flooded with water. Grinding, deburring, removal of metal fragments left from previous machining operations, *Fig.* 2, producing of predetermined radii on edges, polishing, *Fig.* 3, honing and even coloring can be readily accomplished with closely controlled results in mass production of machine parts of all varieties.

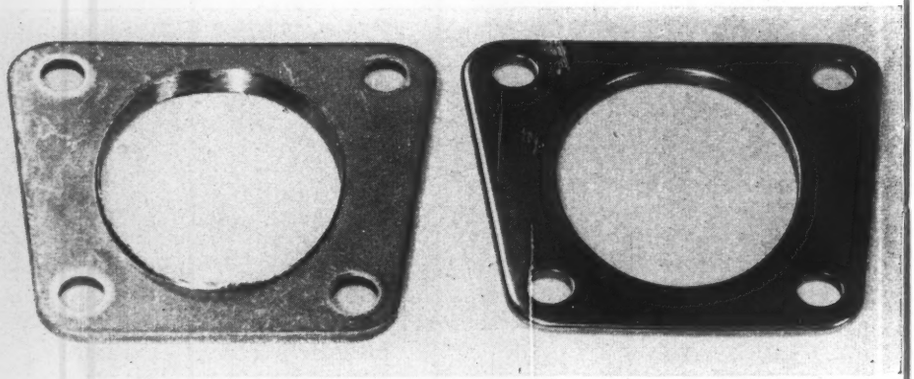


Fig. 3—Stainless steel plate deburred, radiused and polished in two separate tumbling operations at approximately $0.0035 each, a saving of 86 per cent

Practically any material—ferrous, nonferrous, plastics, etc.—both in hardened and soft condition can be readily finished in the continuous-rotation tumbling barrel with proper technique. Parts may be rough castings or forgings, stampings, spinnings, precision castings, or accurately finish-machined pieces such as cams, gears, *Fig.* 4, threaded units, gun mechanisms, housings, bearing rollers, cages and rolls, brackets, ratchets, etc., of practically any design and may range from a few ounces to 75 pounds.

The wet method is recommended and best suited for grinding, deburring and finishing the majority of parts. Grinding utilizes the largest chips or stones for fast cutting in eliminating burrs, fragmented metal, sharp or rough corners and edges. Grinding also removes spinning, draw and die marks, tool marks or machined surfaces, etc. Honing action is obtained by the use of the smaller stones or chips and naturally results in a much finer surface finish approaching a polish. So-called "coloring" is an extremely fine fine finishing operation using the finest chips or, in some cases, highly polished hard steel balls and is especially well suited to the processing of small, irregularly shaped pieces.

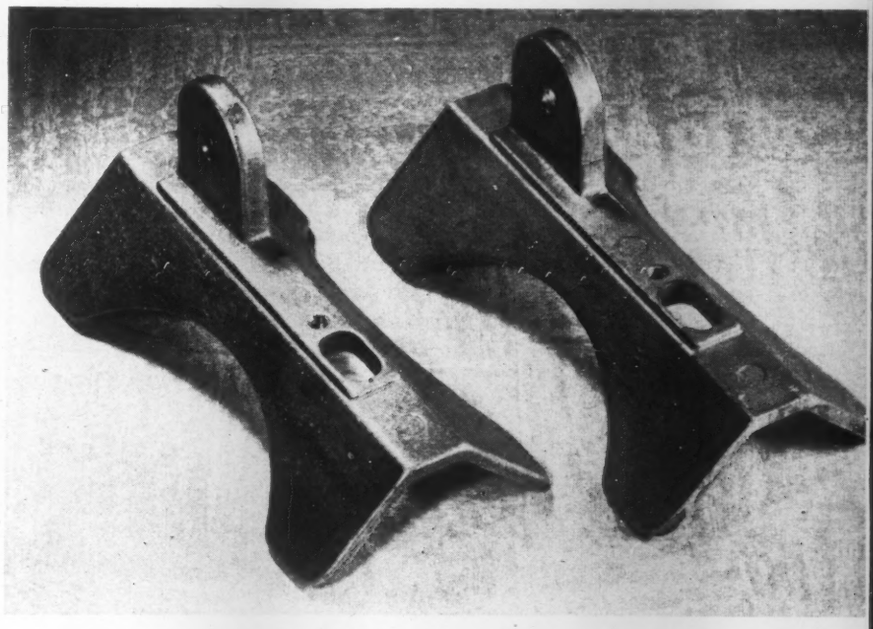
In a continuous tumbling process, action of the abrasive stones to grind off burrs and shrap projections occurs because these projections rupture the protective water film and subject the burr or irregularity to the direct abrasive impact. Honing action on flat surfaces is limited primarily to the removal of raised portions or projections left by tools used in the previous processing, the water operating as a lubricant to keep the stones from cutting deeply. This results in a controlled precision honing which rarely exceeds a few millionths of an inch on most surfaces while almost uniform radii are produced on all edges as exemplified by the gun trigger in *Fig.* 2. Different sections of a part are usually affected by the chip action in the following order: Sharp corners, edges, convex surfaces, flat surfaces, concave surfaces, and last of all, deeply recessed or relatively inaccessible locations.

Dry barrel finishing is somewhat limited and used primarily for the final honing of die castings, *Fig.* 5, and brass castings after a preliminary fast wet grinding operation with large stones. It is also used widely for finishing small, light-gage stampings of all metals as well as brass stampings, etc., prior to electroplating.

Value of barrel finishing as a mass production process over and above its well known employment in burring and conditioning readily can be seen. Not only can burring of sharp projections be accomplished at extremely low cost per piece, but tremendous improvement in surface quality can be produced simultaneously without significant reduction in finished dimensions or risk of additional stress-raising cracks or scratches. Barrel finishing also provides an economical method upon which the designer can rely when designing intricate machine and instrument parts whose proper functioning depends upon the complete removal of flash, sharp edges and burrs, *Fig.* 6, a condition which normally would place many parts beyond the reasonable cost bracket if hand methods were contemplated. In fact, the designer can safely specify uniformly radiused edges throughout a part without fear of complicated operations, *Fig.* 7.

Use of barrel finishing, in addition, often makes it unnecessary to obtain the most exacting surface finish possible by means of the primary processing method; the honing action of the stones removes grinding wheel marks, machining tool marks, die scratches, etc., and where desired can improve surface finish to as fine as 3 microinches, depending upon conditions such as surface finish left by prior processing, physical design features of the part, edge radii desired, economical time cycle, etc.

Naturally, some limitations exist which prohibit the use of barrel finishing on certain types of parts. Edges which must be broken to a smooth radius, of course, would be impossible to finish when so located as to prevent direct action of the abrasive media. Again, holes may be too small to allow free circulation of the stones, or inner passages may be of such intricacy as to result in excessive



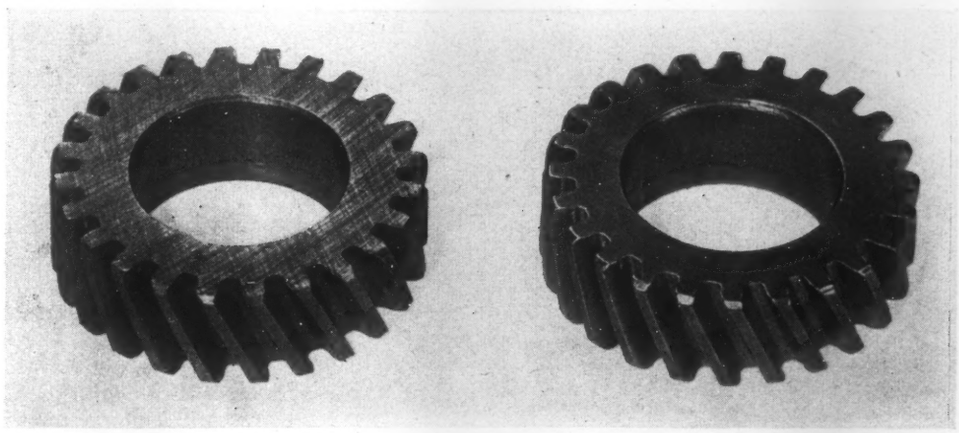


Fig. 4—Left—Mild steel gear barrel finished at $0.018 per gear as compared to $0.06 previously, provided greater uniformity, increased production and tooth surfaces approaching the so-called run-in tooth condition

Fig. 5—Above—Die-cast cradle for Argus Spotting Scope tripod adapter before and after barrel finishing which increased output from 120 per hour to 600

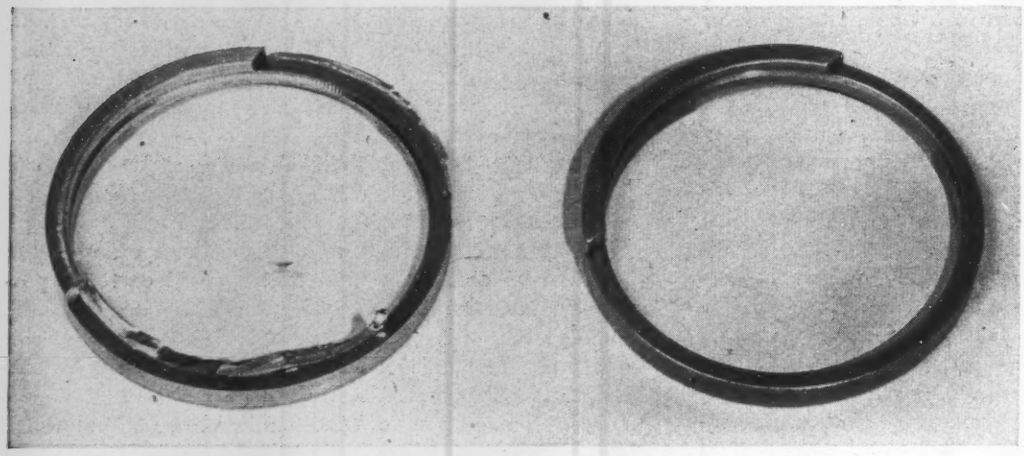


Fig. 6—Left—Commutator holding ring barrel finished to assure proper functioning at minimum cost

cleaning problems. Where loose abrasive is employed with smooth stones, impingements between parts having sharp corners, flat surfaces and projections may result in nicks. This problem sometimes can be eliminated by decreasing the number of parts handled, for example, cast bronze Bofors antiaircraft gun side frames weighing 55 pounds each were finished in 3-compartment barrels, one to a compartment, in 2 hours. In some cases, use of abrasive compound may create a paste and plug blind or tapped holes. Most of these problems are eliminated, however, by utilizing one of the manufactured media—fine abrasive particles formed into graded chips by a soft bond—which provide the maximum in control and result in extremely fine surface finish, *Fig.* 3.

A wide variety of barrels available for processing are of five general types: (1) Tilting, (2) compartment horizontal, (3) tapered horizontal, (4) cylindrical horizontal, and (5) octagonal horizontal. Tilted barrels, with capacities from one to 14 cubic feet, are usually lined with seasoned hardwood and the tilting feature makes them highly economical of handling time. Compartment barrels are usually octagonal in shape and may have from one to 5 compartments, wood lined. Capacities may run from around 3 to 20 cubic feet per compartment. Cast-iron tapered octagonal horizontal barrels, with capacities up to about 5 cubic feet, are primarily for water rolling and sand tumbling metal parts whose rough surfaces are to be cut down and smoothed. Steel cylindrical horizontal barrels, with capacities up to about 30 cubic feet, are primarily for removing fins and flanges from large, heavy castings. Octagonal horizontal barrels, usually of wood with one or more screemed faces, are for dry tumbling of plastics.

Large, compartmented barrels and the tilting type are most widely used for precision finishing work, *Fig.* 8. Speed of rotation varies from about 10 to 50 rpm with 20 rpm being the most useful speed. The time required for processing parts varies considerably with the material, design and finish desired. Time for various metals, roughly, is as follows: For machined brass, 15 minutes to 2 hours; for machined aluminum, 15 minutes to 3 hours; for cast brass, 2 hours to 48 hours; and for deburring steel, from 1 hour to 8 hours. The harder the steel, the brighter the surfaces obtainable but the longer the processing time needed. Production of simple bushings,

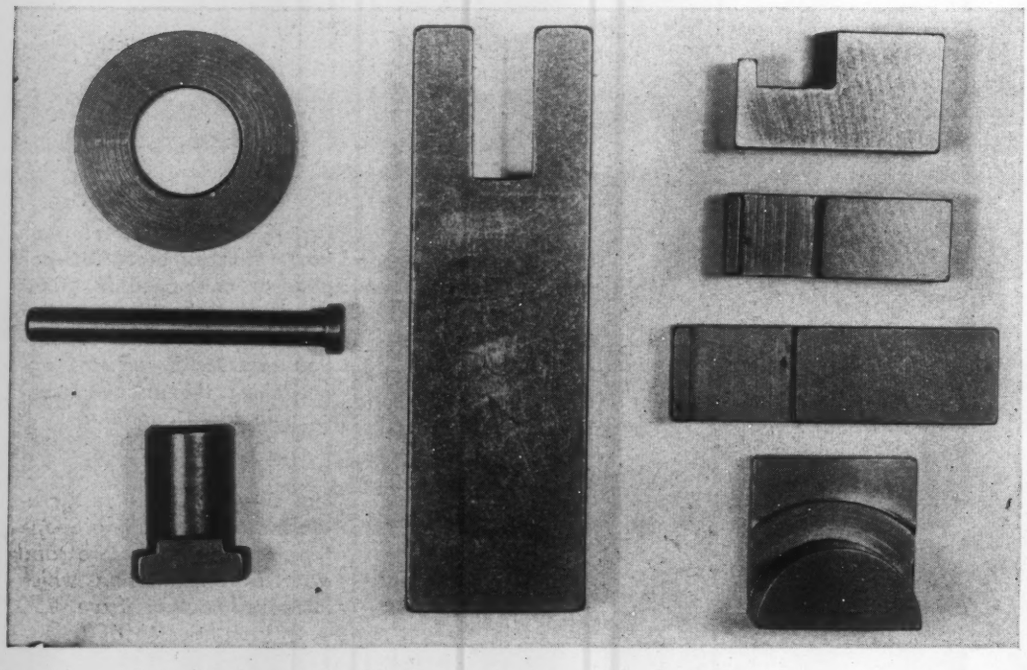


Fig. 7—Left—Large link, key block, pins and blanks for production tools barrel finished to obtain uniform radii

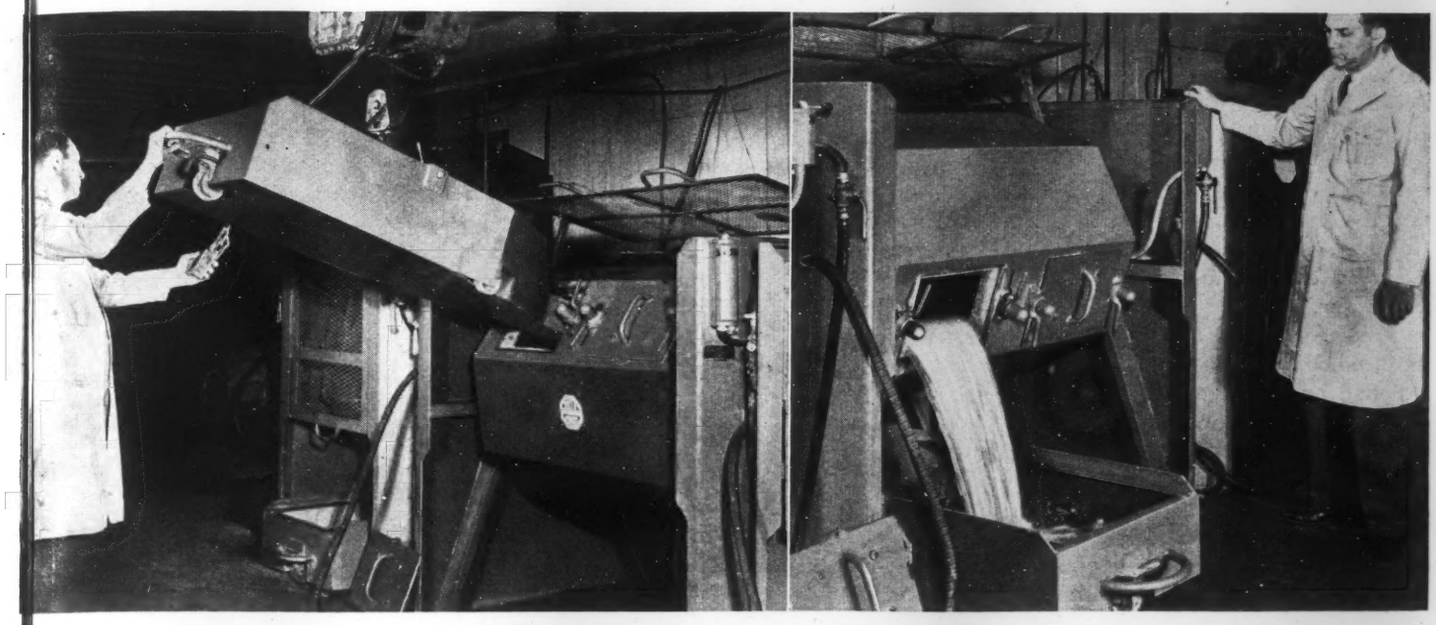


Fig. 8—Large octagonal compartmented barrels are used most widely for precision finishing. Barrel shown loading and unloading quantities of small parts

which by former methods never exceeded 50 to 60, may be processed at from 12,000 to 15,000 per hour. With more complicated parts, such as the gun frame mentioned previously, finishing may run to several hours but where high production rates must be met hand methods would present an unsurmountable problem.

DESIGN: The design of any part is of much importance in the subsequent processing procedures, and the method of finishing required to produce an acceptable part may mean the difference between success or failure so far as economical production is concerned. A part best adapted to barrel finishing should be simple and have no sharp corners or flat surfaces. If design embraces principally sharp corners, edges and large flat surfaces, then the possibility of securing good results sometimes is problematical. Too, it must be remembered that intricate configurations, deep blind holes or slots, recesses, etc., will add to the problems of working out a technique, *Fig.* 9.

With this process in mind the designer can specify smoothly radiused edges throughout a part and be certain these can be held within fairly narrow limits. Commonly, the practical range of radii is from 0.002 to 0.020-inch, but radii up to 0.050-inch and greater have been produced.

MATERIALS: As previously noted, practically any material can be handled. The harder metals require a longer period for processing but present considerably less trouble with nicking. On materials such as die-cast zinc or aluminum, burrs are removed and radii produced quite rapidly. Brass and steel require a slightly longer period as a rule while materials such as stainless steel, being extremely tough, would necessitate the longest period.

In some cases substitute material can be employed with considerable reduction in costs. The bezel ring, *Fig.* 10, formerly made from a carefully hand burred and polished stainless steel, is now blanked in ordinary manner from cold-rolled steel and barrel finished to a highly satisfactory luster at a saving of several dollars per hundred.

TOLERANCES: Normally the grinding operation can be expected to produce a finish of approximately 25 microinches on unhardened parts, the honing operation will bring this down to about 10 microinches, and the wet

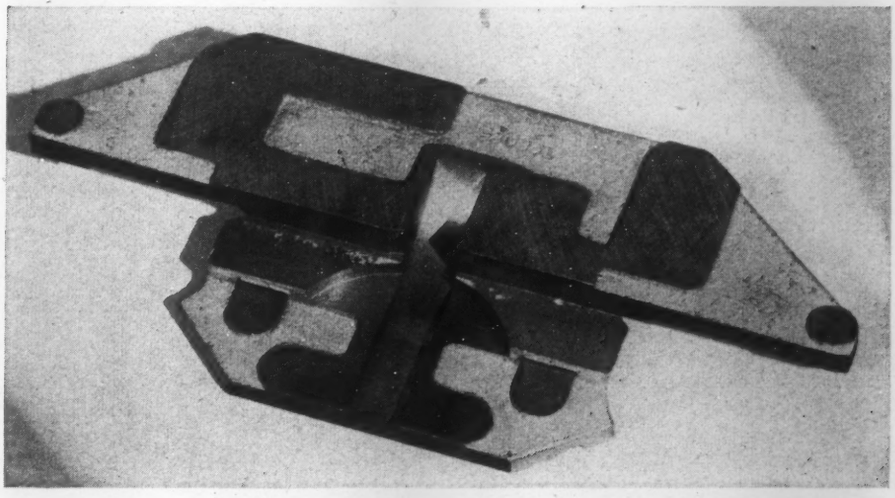


Fig. 9—Right—Barrel finishing techniques for parts such as this type lever segment support can usually be worked out satisfactorily with considerable savings. Finish on segment is smooth and bright with radii of 0.005 to 0.010-inch on all edges and corners

coloring operation, 2 or 3 microinches. Combinations can be used to radius edges while at the same time honing the surface to a high quality.

Uniformity of dimensions and radii after barrel finishing are in exact conformity with those before finishing, i.e., prior processing tolerances set the limits. Overall reduction in dimensions may run from a few millionths to a few tenths depending upon the material and design. However, each piece may be altered somewhat from the more exposed to less exposed portions as previously noted. Projections such as thin burrs are affected first and most; excessive variation in size of burrs from piece to piece may cause a similar variation after tumbling, although much reduced.

Finish tolerances also are affected by prior finish, actual cases showing microinch readings on parts being reduced from 15 before to 3 after, from 60 to 15, from 500 to 80, etc.

Tests on hardened steel samples show that corner spherical radii created increase rapidly to about 0.055-inch in the first 2 hours and then settle down to about 0.003-inch per hour of tumbling thereafter. Edge radii develop much slower, as can be readily noted in *Figs.* 2, 7, and 11, reaching about 0.015-inch in the first 2 hours and then settling down to a rate of 0.001-inch per hour. Dimensional change on flat concave or convex surfaces reaches about 0.00045-inch during the first five hours and thereafter usually proceeds at a rate of 0.0000375-inch per hour.

Naturally part specifications must take into consideration this decrease in dimensions since, on close tolerance parts, final dimensions of a certain percentage may fall below the low limit. Likewise, tolerances on hardness must take into account the several points in rockwell hardness usually imparted by tumbling.

Currently, on aircraft engine parts such as gears, gear-and-spline shafts, bearing retainers, special bolts, housings, etc., surface finishes from 6 to 8 microinches and corner radii of 0.008 to 0.010-inch are consistently obtained.

Often the use of the barrel finishing can produce finish results comparable to grinding at a much lower cost. The part shown in *Fig.* 11 was originally broached, hardened and finish ground. By application of two tumbling operations, one after broaching and one after hardening, it was possible to obtain the extremely satisfactory finish of 8 to 16 microinches along with smoothly finished edges and radiused corners.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Argus Inc. (*Fig.* 5) ..... Ann Arbor, Mich.
Farnsworth Television & Radio Corp. (*Fig.* 1) ..... Fort Wayne, Ind.
Globe Stamping Div., Hupp Motor Car Corp. ..... Cleveland, Ohio
International Business Machines Corp. (*Figs.* 6, 9, 10 and 11) ..... New York, N. Y.
Jones & Lamson Machine Co. (*Fig.* 7) ..... Springfield, Vt.
Minnesota Mining & Mfg. Co. (*Figs.* 2, 3 and 4) ..... St. Paul, Minn.
Sturgis Products Co. (*Fig.* 8) ..... Sturgis, Mich.
Warner & Swasey Co. ..... Cleveland, Ohio

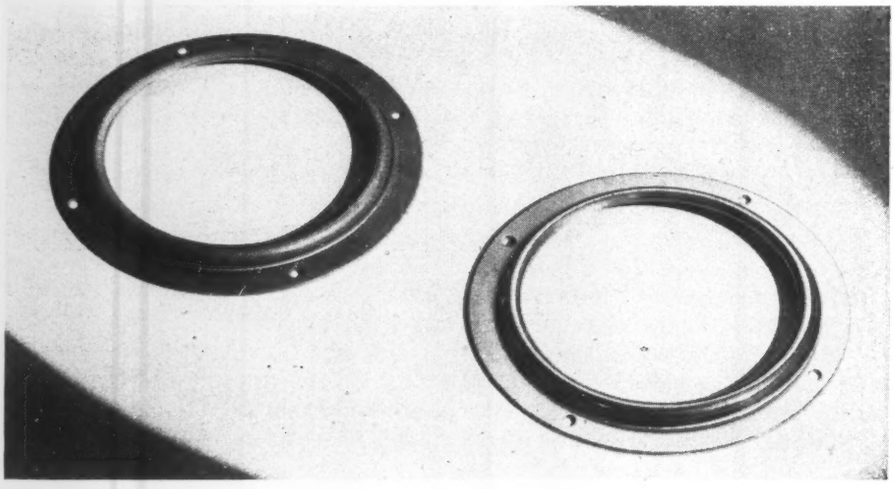


Fig. 10—Above—Use of barrel finishing on ordinary steel provided a high-luster finish equivalent to that obtained previously by hand methods on special stainless

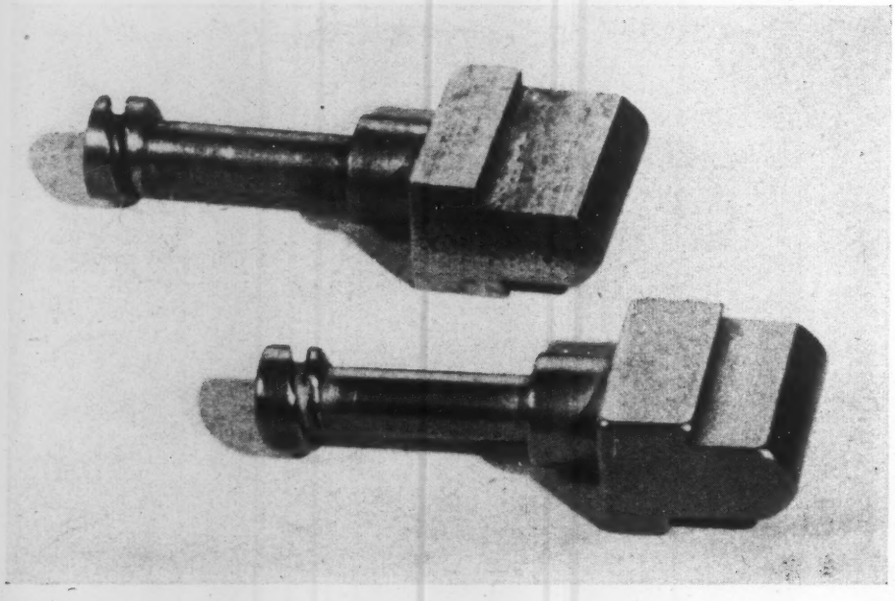


Fig. 11—Left—Two tumbling operations, following broaching and hardening of this part, eliminated the need for a costly finish grinding operation

MACHINE DESIGN Editorial

Freedom of Action Promises Best Results

Through ignorance of the law or lack of foresight, many engineers have been drawn arbitrarily into collective bargaining units as established under the National Labor Relations act. Little choice has been granted the individual engineer in these instances. He has been compelled to become affiliated with a nonprofessional unit and to be represented by a designated agent who in the majority of cases is not in a position to appreciate fully the character of an engineer's services to his employer.

Such grouping of professional and nonprofessional workers into single units could not be expected to prove satisfactory from the standpoint of either type of employee. Education, training and experience of the professional worker place him in a different category to that of the majority of the members of the heterogeneous group of which he is forced to become a part.

Where engineers and other professional workers have been forewarned, it has been possible to form professional units organized to operate independently of others. Such units, recognized under the labor laws, usually have brought about favorable employer-employee relations. They are, however, difficult to establish and consequently are not sufficiently widespread to take care of the interests of professional employees to any great extent. Furthermore, all of the engineers or professional men in the companies within which the units are created do not necessarily favor their formation.

Certain of the proposed amendments to the Wagner act which at the time this is written are under consideration in Congress would go far toward ironing out the difficult situations that have confronted designers of machines and other engineers. Whatever exact form the amendments finally take, there is reason to hope that the new law will clarify and define the position of the professional worker and at the same time guarantee his right to complete freedom of choice in all matters pertaining to relations with his employer. Engineers should exercise this fredom, if it is granted, to enhance their professional status and avoid any semblance of associating themselves with selfish pressure groups.

L. E. Jerry

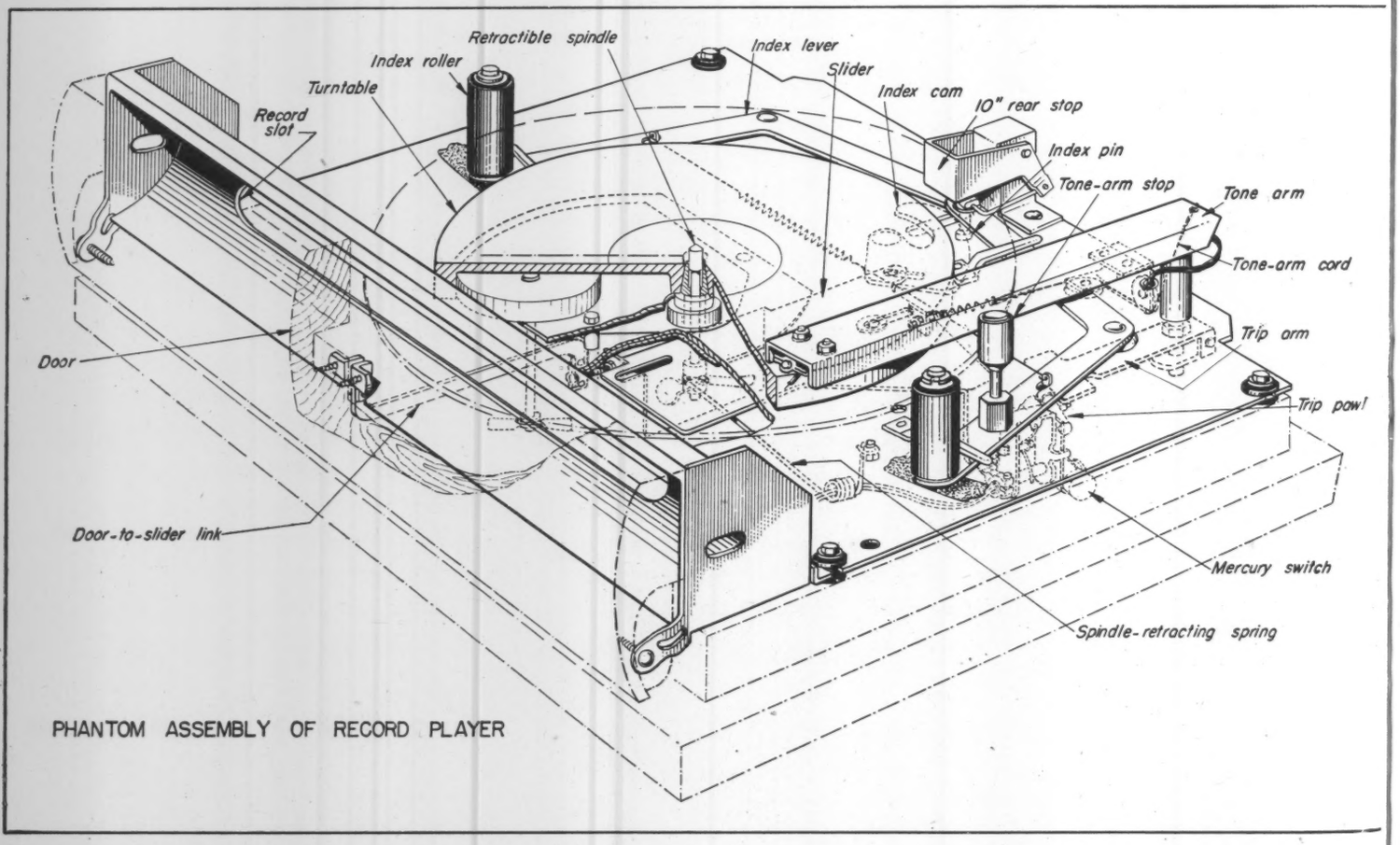
DESIGNS OF THE MONTH

Unique Radio-Phonograph Mechanism

MECHANISM of this combination radio-phonograph (the Philco 1201) automatically adjusts for a ten or twelve-inch record, centers the record over the turntable spindle, sets the needle on the record at the correct location, starts the motor, plays the record, and stops the motor at the end of the record. The door may be opened at any time, either to remove the record or to replay it by reclosing the door.

With the door open, a record is pushed through the slot and between the index rollers until it touches the rear stop. A ten-inch record just clears the rollers but a twelve-inch record spreads the rollers, causing the spring-loaded index levers to swing outward. This lever movement raises the ten-inch rear stop to clear the twelve-inch record by means of a simple linkage allowing it to come to rest against the twelve-inch rear stop. The index pin, which is fastened to a lever, is shown in the ten-inch position and the slider and the index cam are shown in the closed-door position. When the door is opened, the slide, being linked to the door, moves toward the door and the index cam is rotated out of the path of the index pin. With a twelve-inch record on the turntable, the index pin is positioned forward so that it is engaged by the hook on the index cam when the door is closed, thus forcing the pin forward and pulling the index rollers away from the twelve-inch record for clearance.

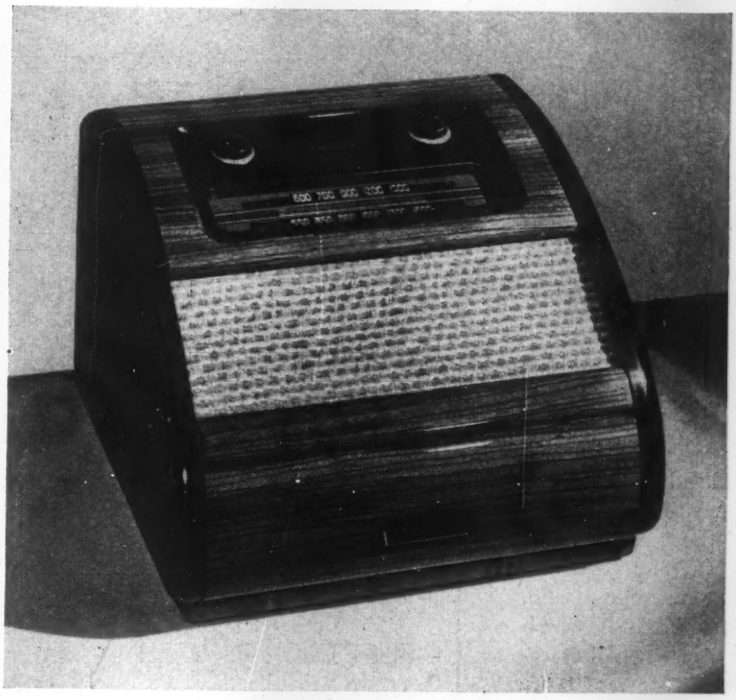
A spring with a looped end passes through a slot in the slider and engages the retractable turntable spindle. As the door closes, the slot in the slider cams the

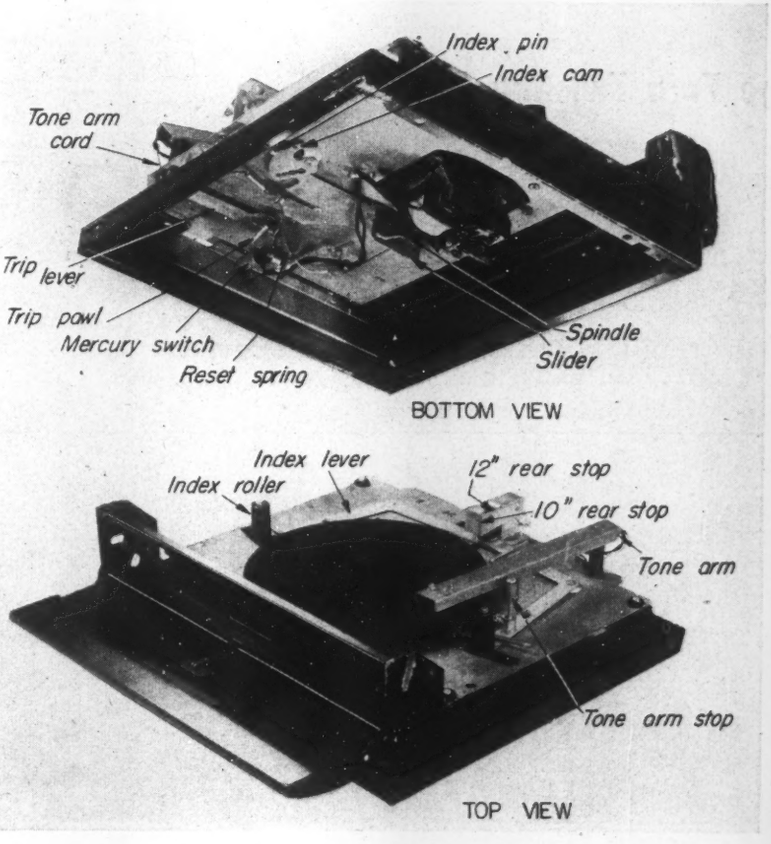


PHANTOM ASSEMBLY OF RECORD PLAYER

spring-end upward, raising the conical-tipped spindle into the center hole of the record to position it precisely on the turntable. A cord is attached to the slider and to the rear of the tone arm, passing over pulleys so that when the door is opened, the tightened cord pulls on the tone arm at an angle, lifting it from the record and swinging it outward until it comes to rest against the tone-arm stop. This stop is fastened to and moves with the index lever so that when the door is closed the tone arm lowers to the correct location on either a ten or twelve-inch record.

Automatic shut-off of the motor is obtained with a mercury switch. The trip arm, attached to the tone-arm shaft, slips over a rubber-tipped pawl as the tone arm moves toward the record center. When this tone-arm motion is periodically reversed as the needle follows the eccentric groove at the end of the record, the arm pushes on the pawl, causing it to rotate the mercury switch holder on its shaft. Two or three traverses of the eccentric groove cause enough cumulative rotation of the switch to open its contacts and shut off the motor. A beryllium-copper reset spring is riveted to the slider at a 45-degree angle so that, as the door is closed, the spring engages a projection on the mercury-switch shaft and rotates it to "on" position. The spring overtravels the projection and snaps underneath it so that when the door is opened the switch is rotated to "off" position, the spring again overtraveling and snapping into position above the projection. Manufacturer: Philco Corporation, Philadelphia 34.

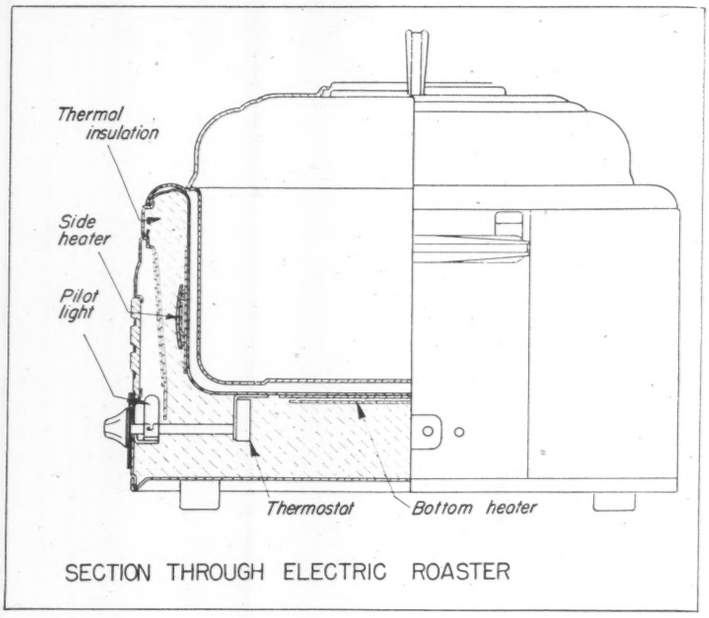




Electric Roaster Features Simplicity

EIGHTEEN-QUART capacity electric roaster (top, next page)—for baking, cooking, frying, roasting and broiling—is simple in design and construction. Heating elements are insulated with asbestos and special cement which is in direct contact with sides and bottom of the enameled cooking well, resulting in highly uniform heat distribution. Removable cooking pan is finished in acid-resistant vitreous enamel which provides excellent transfer of radiated heat to the oven space.

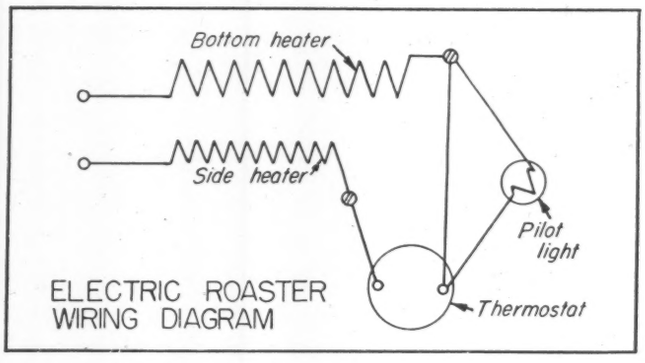
Glass wool is used for thermal insulation around the sides and bottom, providing maximum thermal and electrical insulation per pound and minimum moisture absorption. Control of temperature over a range of 150 to 500 F is achieved through the use of an adjustable bimetal thermostat that is mounted on the underside of the well. A



SECTION THROUGH ELECTRIC ROASTER

small pilot lamp is lit during preheating and at all other times when the thermostat is "on".

Styling is achieved largely through skillful use of color. Body of the roaster is finished in white, heat-resisting, synthetic enamel. A soft gray is used for the inset pan and the handles, blue is used on the nameplate, and the cover is polished aluminum. All handles are of phenolic plastic, the body handles incorporating hook-shaped lugs which serve as a convenient holder for the cover when it is removed from the roaster. Manufacturer: Westinghouse Electric Corp., Pittsburgh 30.

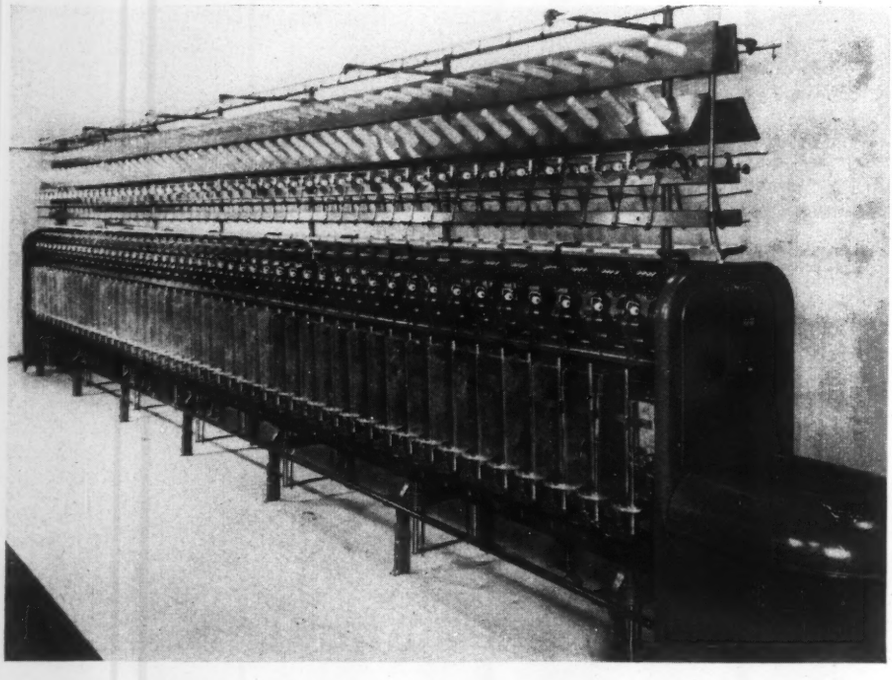


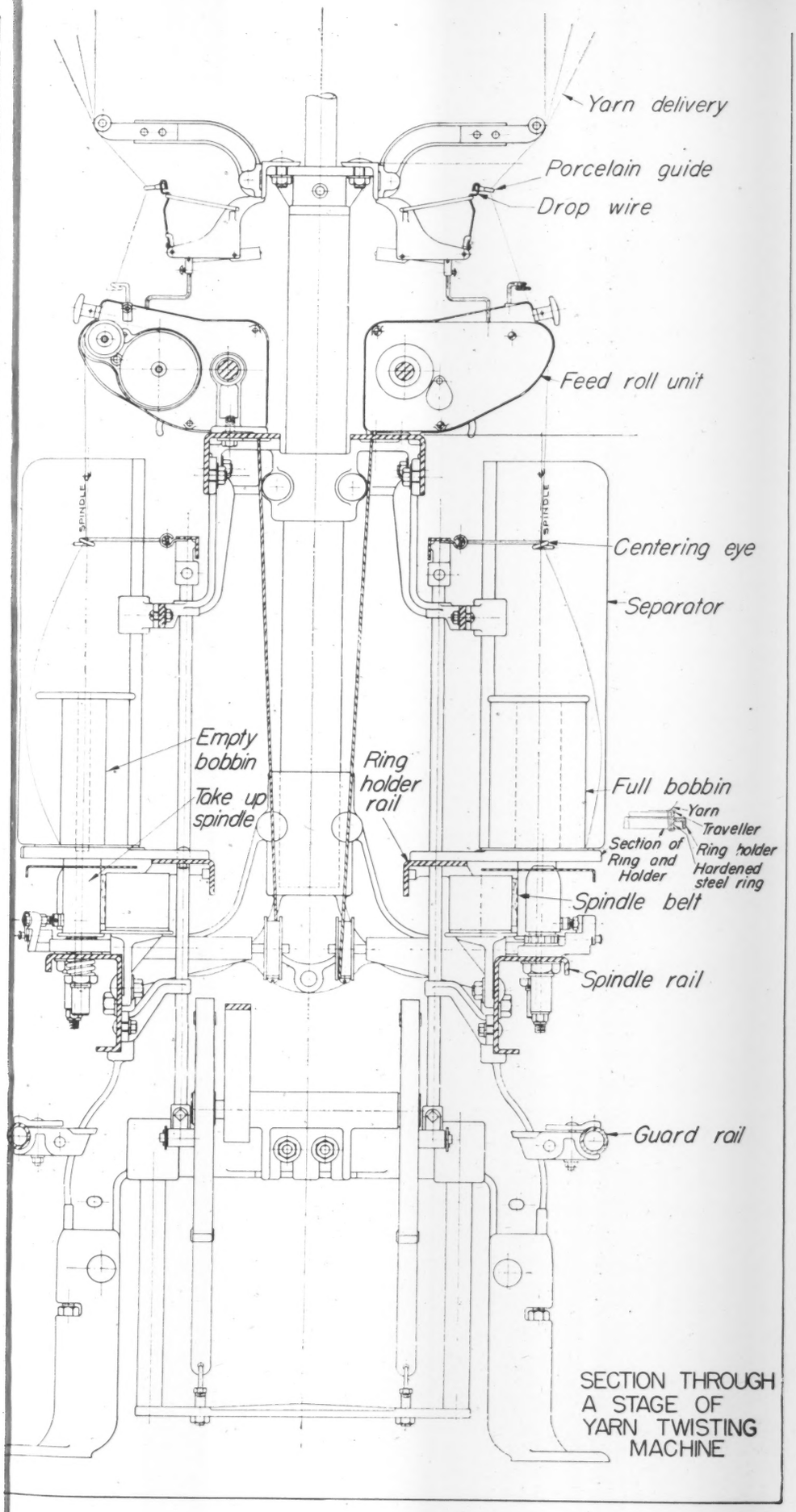
ELECTRIC ROASTER WIRING DIAGRAM

Multistage Yarn Twisting Machine

PURPOSE of this multistage machine is to twist various types of yarn such as rayon, cotton, wool, nylon and silk, or combinations of these yarns preparatory to weaving, knitting or braiding. The delivery packages of yarn are placed in the creel on top of the machine and the yarn is guided through tension devices, then through porcelain guides mounted on drop wires. From the drop wires the yarn is wound around a cast iron feedroll which feeds the yarn to the takeup spindle. This feedroll is highly polished to insure that it will not damage the thread.

The yarn is wound on the takeup package by means of a traveller which is mounted on a hardened steel ring which in turn is held in an aluminum casting mounted on a cold-rolled steel rail. This as-



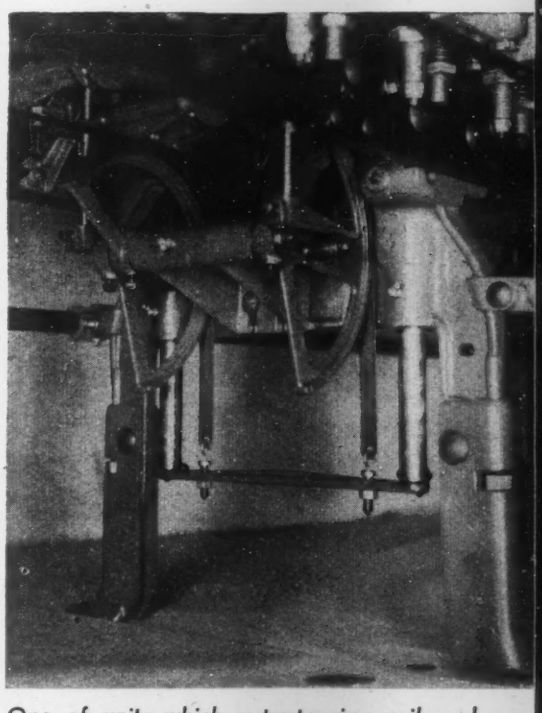


SECTION THROUGH A STAGE OF YARN TWISTING MACHINE

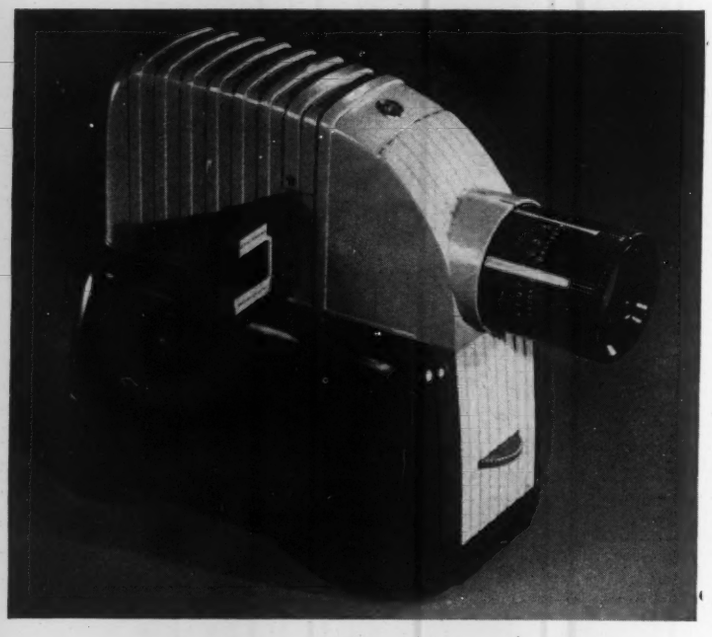
sembly is traversed vertically by a cam or builder motion that controls the shape of the package. In this mechanism, the segments, spring steel straps and lifter rod move in a vertical line, the bearings being an integral part of the middle stand.

Relationship of speed between the feedroll and the takeup spindle controls the twist put into the yarn. The machine is driven by an end-mounted electric motor of special frame dimensions located on a movable carriage supported by ball-bearing rollers. This carriage has an automatic belt takeup arrangement that maintains constant tension on a belt which runs horizontally the full length of the machine and drives the takeup spindles. The belt passes around a pully mounted on a spiral-bevel gear unit on the opposite end of the machine. From this unit there is a silent chain drive to the gearing which controls the twist and the cam motion. Lubrication of the spiral-bevel gear unit is by a continuous-circulating oil system.

The drop wires through which the yarn passes in connection with a built-in stop motion on the feedroll provide individual control of



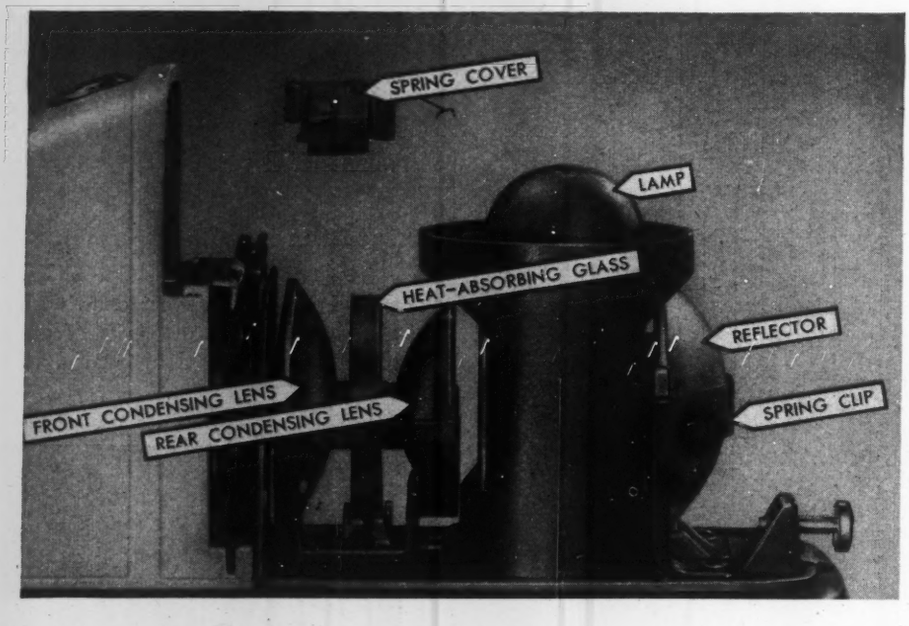
One of units which actuate ring rail and thread board of the yarn twister



each spindle. If one strand of yarn passing through the drop wires breaks, the feedroll and takeup spindle are stopped automatically. Operator of the machine then ties in the broken end of yarn and starts the spindle manually. The thread guides receiving the most wear are hardened, chrome-plated and highly polished. Takeup spindles, of alloy steel, are hardened and ground. Mfr: Atwood Div., Farrel-Birmingham Co. Inc., Stonington, Conn.

Projector Has Lumenized Optics

CONDENSER and projection lenses of this slide projector are Lumenized, that is, coated with a microscopically thin layer of magnesium fluoride to reduce internal reflection and increase light transmission. In addition to the heat-absorbing glass employed in the optical system, pressurized air helps guard transparencies against excessive heat.



Suitable for uses ranging from home to theatrical projection, the projector may be used with any of five lamps rating from 300 to 1000 watts. Interchangeable condenser lenses insure high efficiency with whatever type projection lens is used. Fan employed is designed to send three separate blasts of air past the lamp, the condenser system and the slide itself. The slide carrier and film gate are so designed that the blast of air directed at the slide passes both sides of the transparency. Housing of the projector is die-cast aluminum, finished in two shades of gray. Knob controls tilting mechanism. Manufacturer: Eastman Kodak Co., Rochester 4, N. Y.

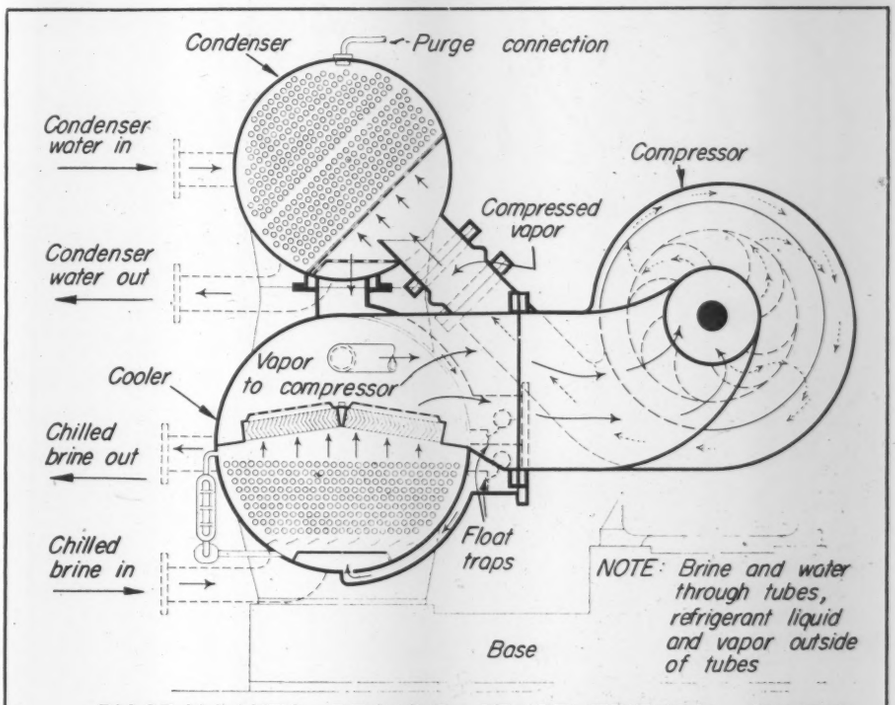
Centrifugal Refrigerating Machine

DESIGNED for use in many types of large-scale refrigeration systems, this centrifugal refrigerating machine is comprised of three major components: Cooler, compressor and condenser. Referring to the diagrammatic drawing, brine or other fluid to be cooled is brought into the tube bundle of the cooler where heat is removed from it by the evaporating refrigerant on the outside of the tubes. This refrigerant, in the vapor phase, flows into the first stage of the compressor. The flash gas from the economizer joins the vapor as it flows into the inlet of the second stage. The compressed vapor, as discharged from the compressor, flows up into the condenser, where it gives up its heat to the condenser water. The condenser water is circulated inside the tubes in the condenser shell, being handled as indicated on the diagram. The liquid flows from the condenser into the upper float trap and then through this float into the lower float trap. Located between these two floats is a chamber (the economizer) in which the liquid is allowed to flash cool itself to a temperature corresponding to a pressure equivalent to the interstage pressure in the compressor. The vapors that are flashed, pass into the compressor, as already noted. The liquid flows into the lower of the two float traps and then through this into the bottom of the cooler. Air and noncondensable vapors that accumulate are removed through the purge connection.

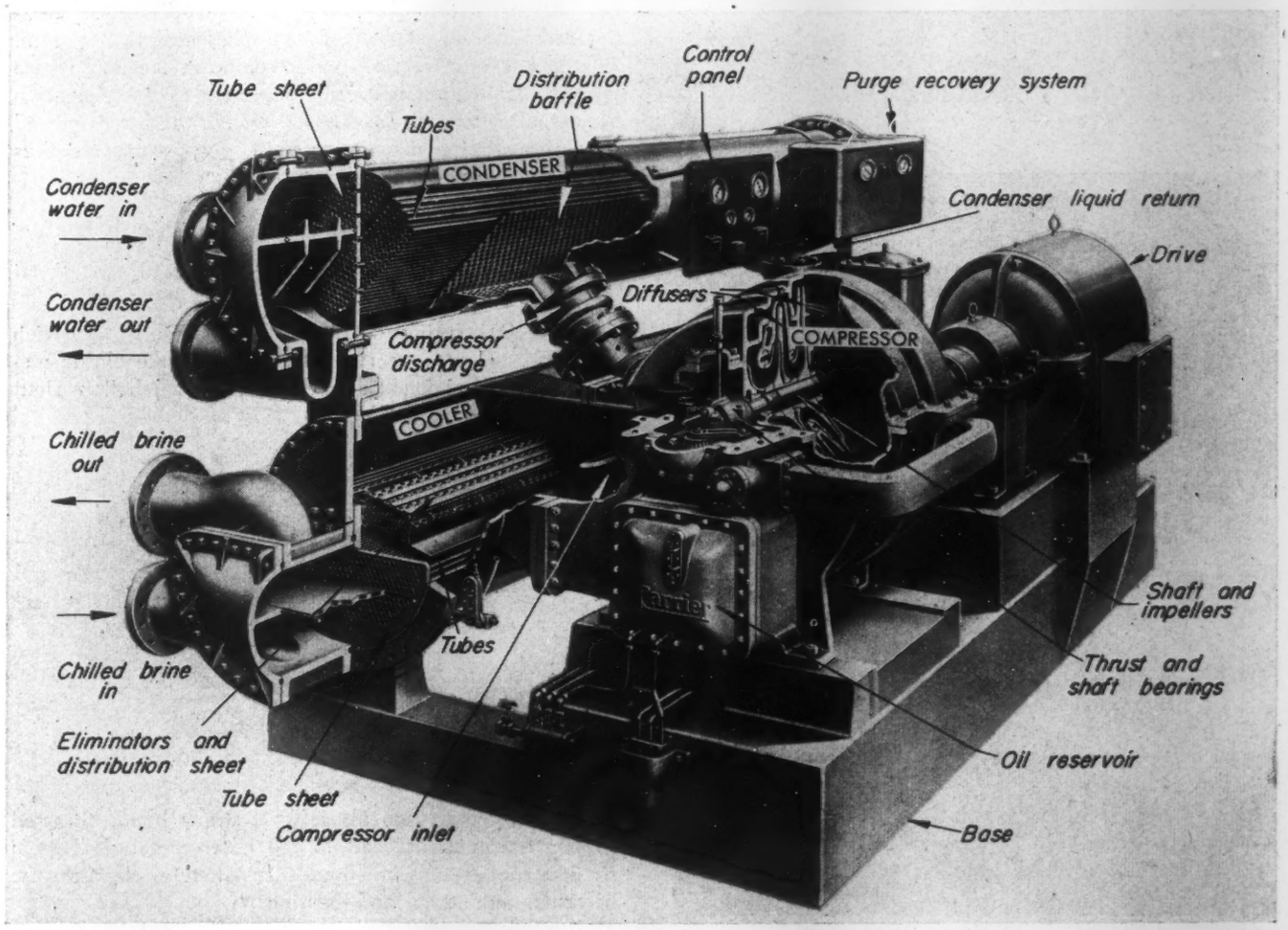
Bearings and shaft seal of the centrifugal compressor are lubricated through lines from a gear type pump which

is located in the bottom of the oil reservoir. The compressor may be driven by: Motor with speedup gear, direct-connected steam turbine, diesel engine, gasoline engine, etc. The heat exchangers (cooler and condenser) are constructed of a welded steel shell and tube sheet arrangement with tubes rolled into cupro-nickel tube sheets. Shells and end flanges are hot-rolled steel. Tubes in both cooler and condenser may be practically any nonferrous alloy, but generally are plain copper. They are of the integral-fin type.

Compressor shell and stationary parts such as diaphragms, intake guide vanes, etc., generally are close-grained gray iron castings. Compressor shaft is heat-treated nickel alloy forging and impeller hubs and covers are special heat-treated forgings. Shaft and impeller labyrinths are used throughout the machine to isolate portions having different pressure differentials. Manufacturer: Carrier Corp., Syracuse, N. Y.

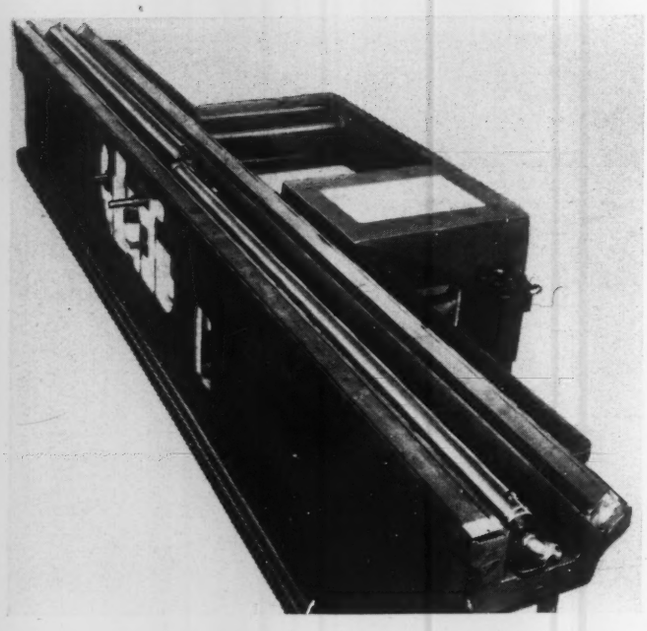


DIAGRAMMATIC DRAWING OF CENTRIFUGAL REFRIGERATING MACHINE



Applications

of engineering parts, materials and processes

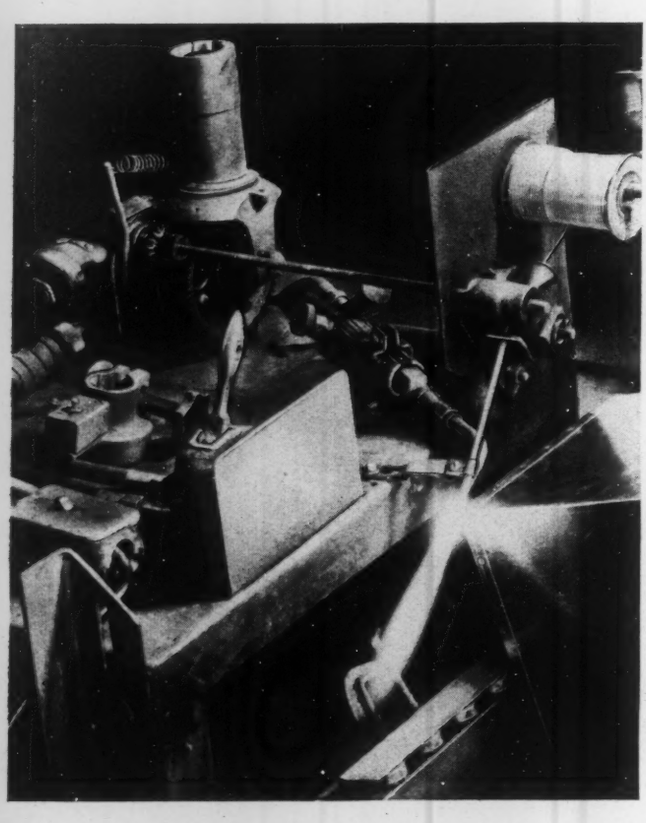


Hydraulic Cylinder is Polished Tubing

STEEL tubing manufactured with highly-polished internal surface is utilized without further internal finishing for hydraulic cylinders on the Landis Tool Co. grinding machine, bed of which is seen at left. Tubing, manufactured by Babcock and Wilcox, is employed in two traversing cylinders which reciprocate the carriage under grinding wheel.

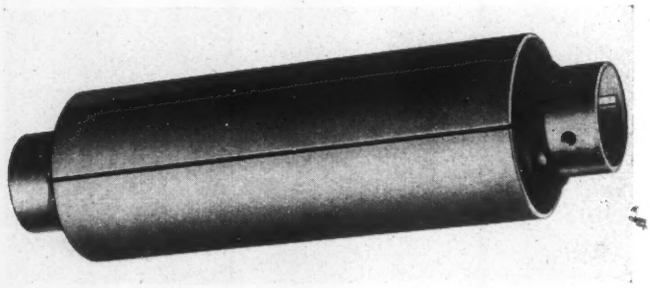
Automatic Soldering Speeds Manufacture

STEEL-BOX seams are soldered automatically by the Linde Air Co. machine seen in the illustration left, below. The folded box, placed on a powered conveyor belt, is carried through the sequence of operations. Fluxing brush, shown at right, first applies acid to the seam. The box is next carried under soldering location where wire solder is automatically supplied to acetylene-rich blowpipe. For each seam to be sealed, the box is passed once through the machine. Tight, even seams are thus produced at great speed.



Torsion Spring Uses Rubber

TORSION spring developed by the B. F. Goodrich Co., below, uses rubber in shear as the elastic medium. Torsional loads applied to the axial hollow shaft



are transferred to the rubber by a strong bond. Stressed rubber transmits its load to the outer metal shell by a similar rubber-to-metal bond. Installation obviates use of seats, mountings and bearings.

Stiffness of Ribbed Plates

By Joseph Marin
Professor of Engineering Mechanics
Pennsylvania State College
State College, Pa.

THIS data sheet presents equations to show the influence of ribs on the strength and stiffness of plates in bending. The accompanying figure shows the cross sections of ribbed and nonribbed plates subjected to bending in the longitudinal direction. For the ribbed plate the overall width is b, which is equal to

$$b=2b_a+nb_r+(n-1)b_1 \quad \ldots\ldots (1)$$

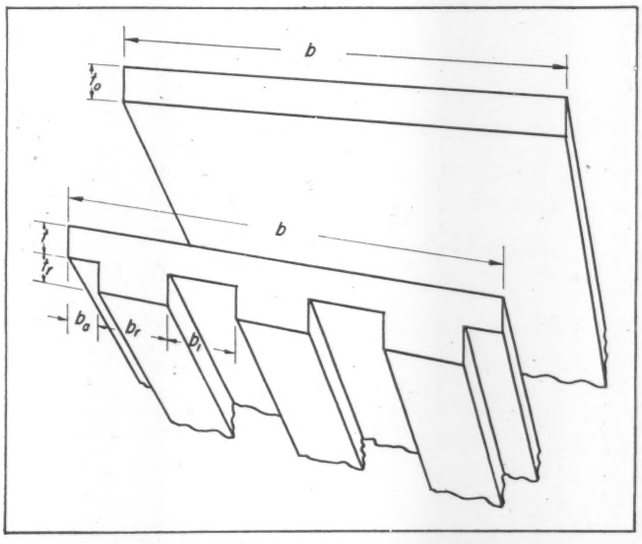
where n is the number of ribs and the b values are as shown in the figure.

RIBBED SECTION MOMENT OF INERTIA: In order to determine the strength and stiffness of the ribbed cross section in the figure it is necessary first to determine the centroidal axis. If this axis is located at a distance y from the top, then by moments of areas the value of y is defined by

$$(tb+nb_rt_r)\bar{y}=\frac{tbt}{2}+nb_rt_r\left(t+\frac{t_r}{2}\right)$$

or

$$\bar{y}=\frac{t}{2}\left[\frac{1+n\frac{b_r}{b}\frac{t_r}{t}\left(2+\frac{t_r}{t}\right)}{1+n\frac{b_r}{b}\frac{t_r}{t}}\right] \quad \ldots\ldots (2)$$



Basic dimensions of ribbed and unribbed plates

Moment of inertia of the cross section about the centroidal axis can now be found. Its value is

$$I_1=I_a+I_b$$

$$=\left[\frac{bt^3}{12}+bt\left(\bar{y}-\frac{t}{2}\right)^2\right]+$$

$$\left[\frac{nb_rt_r^3}{12}+nb_rt_r\left(t+\frac{t_r}{2}-\bar{y}\right)^2\right] \quad \ldots\ldots (3)$$

Placing the value of y from Equation 2 in Equation 3,

$$I_1=\left(\frac{bt^3}{12}\right)\left(\frac{1+k_1+k_2+k_3}{k_4^2}\right) \quad \ldots\ldots (4)$$

where

$$\left.\begin{aligned} k_1&=\left(\frac{nb_r}{b}\right)\left(\frac{t_r}{t}\right)\left(5+6\frac{t_r}{t}+4\frac{t_r^2}{t^2}\right)\\ k_2&=\left(\frac{nb_r}{b}\right)^2\left(\frac{t_r}{t}\right)^2\left(4+6\frac{t_r}{t}+5\frac{t_r^2}{t^2}\right)\\ k_3&=\left(\frac{nb_r}{b}\right)^3\left(\frac{t_r}{t}\right)^5\\ k_4&=\left(1+\frac{nb_r}{b}\frac{t_r}{t}\right)\end{aligned}\right\} \quad \ldots\ldots (5)$$

STIFFNESS COMPARISON: In comparing the ribbed and nonribbed sections the case in which the weights of the two castings are equal will be considered, that is, the cross-sectional areas are equal or, from the figure,

$$nb_rt_r+bt=bt_0$$

or

$$t_0=t\left(1+\frac{nb_r}{b}\frac{t_r}{t}\right) \quad \ldots\ldots (6)$$

Moment of inertia of the nonribbed plate is

$$I_0=\frac{bt_0^3}{12} \quad \ldots\ldots (7)$$

Substituting t_0 from Equation 6 in Equation 7,

$$I_0=k_4^3\left(\frac{bt^3}{12}\right) \quad \ldots\ldots (8)$$

where k_4 is defined in Equation 5. Then from Equations

4 and 8 the ratio of the stiffness of the ribbed plate to that of the nonribbed plate of the same area becomes

$$\frac{I_1}{I_0}=\frac{1+k_1+k_2+k_3}{k_4^5} \quad \ldots\ldots (9)$$

where the k values are given by Equations 5.

Deflections produced in the ribbed and nonribbed plates will be inversely proportional to the I values, that is, if y_0 = the deflection for the nonribbed plate and y_1 = the deflection for the ribbed plate.

$$\frac{y_0}{y_1}=\frac{I_1}{I_0} \quad \ldots\ldots (10)$$

STRENGTH COMPARISON: The strength in bending is defined by the value of M in the beam formula

$$S=\frac{Mc}{I} \quad \ldots\ldots (11)$$

For the ribbed and nonribbed plates the values of the strengths are, respectively,

$$M_1=\frac{I_1 S}{c_1} \quad \ldots\ldots (12)$$

and

$$M_0=\frac{I_0 S}{c_0} \quad \ldots\ldots (13)$$

The strength ratio by Equations 12 and 13 is

$$\frac{M_1}{M_0}=\left(\frac{I_1}{I_0}\right)\left(\frac{c_0}{c_1}\right) \quad \ldots\ldots (14)$$

The value of $c_0 = t_0/2$ and the value of c_1 is the maximum of the following two values

$$c_1=\bar{y} \quad \ldots\ldots (15a)$$

or

$$c_1=t+t_r-\bar{y} \quad \ldots\ldots (15b)$$

where $\bar{y}$ is defined by Equation 2. That is,

$$c_1=k_5\frac{t}{2} \quad \ldots\ldots (16a)$$

or

$$c_1=\frac{t}{2}(2-k_5)+t_r \quad \ldots\ldots (16b)$$

where

$$k_5=\frac{1+n\frac{b_r}{b}\frac{t_r}{t}\left(2+\frac{t_r}{t}\right)}{\left(1+n\frac{b_r}{b}\frac{t_r}{t}\right)} \quad \ldots\ldots (17)$$

Then

$$\frac{M_1}{M_0}=\left(\frac{I_1}{I_0}\right)\left(\frac{t_0}{t}\right)k_5 \quad \ldots\ldots (18)$$

or

$$\frac{M_1}{M_0}=\left(\frac{I_1}{I_0}\right)\left(\frac{t_0}{t}\right)\left(\frac{1}{2-k_5+2\frac{t_r}{t}}\right) \quad \ldots\ldots (19)$$

The minimum strength ratio, of the two defined in Equations 18 and 19, is the governing one. In these equations, I_1/I_0 is defined by Equation 9 and K_5 is defined by Equation 17.

APPLICATION: As an example, it is required to determine the ratio of stiffness and strength for the two plates in the figure when $t_r = t$ and $(nb_r/b) = 1/2$, that is, where the width of the ribs (b_r) equals the width of the openings (b_1).

By Equations 5, $K_1 = 15/2$, $K_2 = 15/4$, $K_3 = 1/8$, and $K_4 = 3/2$. Then by Equation 9 the ratio of the stiffness is

$$\frac{I_1}{I_0}=\frac{\left(1+\frac{15}{2}+\frac{15}{4}+\frac{1}{8}\right)}{(3/2)^5}=1.63$$

That is, the ribbed plate is 1.63 times as stiff as the nonribbed plate or the deflection of the nonribbed plate is 1.63 times that of the ribbed plate.

Strength ratio is defined by Equations 18 and 19. From Equation 6, $t_0/t = 1 + 1/2 = 3/2$. The value of K_5 is, by Equation 17,

$$k_5=\frac{1+\frac{1}{2}(3)}{1+\frac{1}{2}}=\frac{5}{3}$$

From Equation 18,

$$\frac{M_1}{M_0}=(1.63)\left(\frac{3}{2}\right)\left(\frac{5}{3}\right)=4.08$$

Using Equation 19,

$$\frac{M_1}{M_0}=(1.63)\left(\frac{3}{2}\right)\left(\frac{1}{2-1.67+2}\right)=1.05$$

That is, the ribbed plate is 1.05 times as strong as the nonribbed plate.

TEST RESULTS: The foregoing stiffness analysis was confirmed by tests, which showed the actual stiffness ratio in a particular case to be only 2½ per cent less than the theoretical. Ultimate strength ratio, however, was actually 24 per cent less than the theoretical due to premature failure produced by stress concentration. Generous use of fillets should yield actual strength closer to the theoretical.

The main conclusion to be reached from the foregoing analysis is that the use of ribs can be made to increase the stiffness considerably for a cast plate of fixed weight under bending. The increase in strength, however, is small when ribs are used and careful design is necessary to avoid actually weakening the plate due to stress concentrations.

MACHINE DESIGN'S

MATERIALS WORK SHEET

FILING NUMBER
7.06

Meehanite

All Types

TYPES AVAILABLE

General Engineering Types ..... GM, GA, GAII, GB GC, GD, and GE

Heat-Resisting Types ..... HA, HB, HD, HE, HR, and SC

Wear-Resisting Types ..... WA, WAH, WB, Special WB, WBC, Standard WH, Modified WH, and WEC

Corrosion-Resisting Types ..... CB, CB3 and KC

GENERAL ENGINEERING TYPES

Properties	Types GM	GA	GB	GC	GD	GE
Minimum Section Thickness (inches)	5/8	1/2	1/2	3/8	1/4	1/8
Tensile Strength (min, psi, 1.2-in. diam bar)	55,000	50,000	45,000	40,000	35,000	30,000
Modulus of Elasticity (psi)	23,000,000	21,000,000	19,000,000	17,500,000	15,000,000	12,000,000
Transverse Strength (1.2-in. bar—18-in. centers)						
Load (pounds)	3300-3700	3100-3600	3000-3400	2900-3300	2600-3000	2000-2600
Deflection (inches)	0.28-0.34	0.28-0.34	0.28-0.34	0.26-0.34	0.22-0.34	0.20-0.34
Compressive Strength (psi)	200,000	175,000	160,000	150,000	130,000	120,000
Fatigue Strength (psi)	25,000	22,000	19,000	17,500	15,000	13,700
Charpy Impact Strength (ft-lb.)	8.0	7.2	5.8	4.5	3.2	2.1
Brinell Hardness, as cast (min)	217	207	196	192	183	174
Specific Gravity	7.34	7.31	7.28	7.25	7.22	7.16

Relationship of Tensile Strength and Hardness to Section Thickness

Type GA			Type GB			Type GC		
Thickness (inches)	Tensile Str. (psi)	Brinell Hard. No.	Thickness (inches)	Tensile Str. (psi)	Brinell Hard. No.	Thickness (inches)	Tensile Str. (psi)	Brinell Hard. No.
1	50,000	240	1	44,300	225	1	40,000	218
3/4	51,000	245	3/4	45,700	228	3/4	41,800	220
1/2	51,250	270	1/2	47,700	241	1/2	44,700	230

Type GD			Type GE		
Thickness (inches)	Tensile Str. (psi)	Brinell Hard. No.	Thickness (inches)	Tensile Str. (psi)	Brinell Hard. No.
1	34,900	208	1	30,000	200
3/4	37,400	208	3/4	31,500	200
1/2	42,000	215	1/2	34,700	205

HEAT-RESISTING TYPES

	Types HA	HB	HD	HE	HR	SC
Maximum Working Temperature, (deg F)	1200	1400	1150	*	1550	1650
Tensile Strength (psi, min)	50,000	38,000	33,000	30,000	40,000	27,000
Modulus of Elasticity (psi)	21,000,000	19,500,000	17,500,000	12,000,000	21,000,000	17,500,000
Transverse Strength (1.2-in. bar—18-in. centers)						
Load (pounds)	3250	2860	2600	2300	2860	1500
Deflection (inches)	0.28	0.26	0.24	0.28	0.24	0.17
Brinell Hardness, 1-in. section (min)	223	300	223	223	300	300
Thermal Conductivity, 50-450 F (Btu/hr/sq ft/in. thickness/deg F)	350	360	325	290	360	278
Coef. of Thermal Expansion (per deg F) from 100 to 1000 F	.00000687	.00000728	.00000709	.00000666	.00000743	.00000674

* Type HE castings are used for parts subject to alternate heating and cooling.

MACHINE DESIGN is pleased to acknowledge the collaboration of Meehanite Metal Corporation in this presentation.

Elevated Temperature Properties

Temperature (deg F)	Approx. Creep Strength (psi) Less than 1% Creep per 1000 Hours Type HD	Type HB	Type HR	Maximum Growth (inches per inch per year) Type HD	Type HB	Type HR
800	3800	....	....	Nil	.....	.....
900	3800	....	....	Nil	.....	.....
1000	3200	6000	....	Nil	Nil	.....
1100	2300	3750	4000	0.002	Nil	.....
1150	1600	3000	3150	0.005	Nil	.....
1200	....	2250	2500	.....	0.001	0.001
1300	....	1600	1800	.....	0.002	0.002
1400	....	800	900	.....	0.005	0.005
1450	....	....	300	.....	.....	0.010

CHARACTERISTICS

Meehanite castings are produced by controlled processes to meet specific service requirements. Regulation of the quantity and disposition of graphite and the adjustment of the micro-constituents permits achievement of the required characteristics. Like tool steel, Meehanite contains no free ferrite. It consists of either pearlite or sorbite into which are introduced graphite flakes regulated as to form and quantity.

General Engineering Types: These are the most widely used types and are applied in industry for all kinds of machinery and machine tool construction, for permanent molds, dies, pressure castings, tool shanks and milling cutter bodies, valves, etc. Close control in manufacture permits precise specification within the property ranges described, as well as stability of form, good wear resistance, and good response to heat treatment.

Heat-Resisting Types: Offer tensile strengths ranging from 27,000 to 50,000 psi, good creep strength, minimum growth, and working temperatures from 1150 F to 1650 F depending on the type employed. Type HE castings are used in installations where parts are subjected intermittently to heating and cooling.

Wear-Resisting Types: *Type WA* provides tensile strengths to 50,000 psi. However, it does not offer extreme hardness, brinell values from 196 to 321 being obtained according to requirements. This metal has a tough, dense uniform grain structure and a high endurance limit, making it adaptable to certain applications subjected to severe stresses and wear. It is not recommended for hard abrasive wear.

Type WAH provides tensile strengths to 70,000 psi and hardness values to 500 brinell. It may be machined before being hardened when brinell hardness is under 350. Its properties are secured through heat treatment.

Type WB is a hard, dense metal having unusual wear-resistant qualities. Its tensile strengths range to 38,000 psi and it brinells from 350 to 475. This metal is particularly resistant to abrasive wear but is nonmachinable.

Special WB is processed to provide extra qualities. It may be supplied in both machinable and nonmachinable condition, control of the various elements permitting a definite flexibility. Tensile and impact properties can be of high order with brinell hardness up to 500 as cast, or 600 heat-treated.

Type WBC castings are chilled and provide a hard surface backed by a tough body. Depth and hardness of the chill may be adjusted to specification with the hardness controlled up to 475 brinell. Tensile strengths of the base metal range to 45,000 psi. Castings of this metal provide a hard exterior which does not spall or chip.

Standard WH provides a combination of strength and toughness with exceptional hardness and wear resistance.

Modified WH provides less hardness than Standard WH but offers greater strength and toughness. However, 500 brinell in combination with the strength and impact properties of the higher strength types of Meehanite may be obtained.

Type WEC, a recently developed material, is recommended for chill castings where a deep hard chill is the first requirement. It is not suitable for severe impact stressing.

Corrosion-Resisting Types: *Type CB,* most widely used to resist dilute acids and chemicals, has tensile strengths to 45,000 psi and brinells at 187 and higher.

Type CB3, a similar material to Type CB from the standpoint of brinell and tensile, but alloyed to provide good reistance to concentrated sulphuric acid, has provided good service in contact plants with acids up to 105 per cent (oleum) and temperatures up to 200 F.

Type KC, developed to handle strong alkaline conditions, is not used extensively.

APPLICATIONS

GENERAL ENGINEERING TYPES:

Type GM: Crankshafts, pressure castings, cylinders, gears. Dominant properties are high fatigue and tensile strengths in combination with a dense, tough structure.

Type GA: Jigs and fixtures, gears, cams and camshafts, small crankshafts, lathe spindles, chucks, tool slides, dies. As-cast properties include high strength, impact and wear reistance, and good machinability.

Type GAH: Cams, collets, dies, bearings, gears, connecting rings, pinions, diesel-engine cylinder liners. Properties are acquired by heat treatment. Tensiles to 75,000; brinell controlled as desired.

Type GB: General machinery castings, pressure castings, pump parts, cylinder blocks, dies, press castings. Used wherever above-average properties are required in general machinery and machine tool applications. Better machinability than Type GA.

Type GC: Brake drums, permanent molds, lathe beds, bases, piston ring stock, engine castings, pistons. Better machinability than Type GB.

Type GD: All types of miscellaneous castings where design requires lightweight sections and production demands rapid machinability.

Type GE: Particularly applicable to all thin-sectioned, light-weight castings and wherever a soft, highly machinable casting is required.

HEAT-RESISTING TYPES:

Type HA: Diesel castings, valves, liners, manifolds, burner parts. A dense material maintaining as-cast strength up to about 950 F; dimensionally stable up to 1200 F.

Type HB: Stoker plates, grates, furnace-skid castings, fur-

nace lips, incinerator liners, tuyeres, burner cones, furnace rolls and jambs. A hard, dense material resistant to abrasion and free from growth up to 1650 F.

TYPE HD: Calcinator bodies, cement clinker conveyor grates, furnace castings, burner plates, grate bars, etc.

TYPE HE: Ingot molds, retorts, fittings, slag pots, acid and lead pots. A free-machining material recommended for applications where intermittent heating and cooling take place.

TYPE HR: Furnace and burner parts, pedestals, gas retort parts, stoker parts, sugar retorts, furnace skids, blast furnace parts, grate bars, and tempering tanks. A hard material machinable by sintered carbide tools.

TYPE SC: Annealing boxes, carburizing boxes and retorts, baffle plates, furnace slides and plates, and fire grates. If heat is held fairly constant this material will not grow at temperatures up to 1650 F, and scales very slowly.

WEAR-RESISTING TYPES:

TYPE WA: Agitator teeth for cement slurry, brake drums, cams, conveyor rolls for strip mills, dredge-pump liner rings (these may be Type WA or Modified WH according to what fabricating conditions permit), eccentric shafts and pinions, gears, glass molds, liner plates for blast furnaces, plunger sections for deep-well oil pumps, pulverizing hammers, sheaves, truck wheels, and valve bodies.

TYPE WAH: Bearing bushings, cams, clay-cutting worms, gears, grinding and lapping plates for steel balls, liners, screen bars for coke screens, shoes used for earth-tamping equipment.

TYPE WB: Ash conveyor liners, bottom segments for silica rock-crushing mills, certain sand blast nozzles, crusher balls for copper ore, crusher rings and segments, liner plates for mine sluices, mill liners, mixer paddles for mixing clay, pug mill knives and blades, pulverizing hammers, pump impellers, roll guides, rolling mill guides, and sawdust conveyor liners.

SPECIAL WB: Crusher rings and segments, pug-mill knives and blades, pulverizing hammers, pump bodies, pump impellers, roll guides, spike dies, trough covers, etc.

TYPE WBC: Ball-mill crusher plates, ball-mill liners for cement mills, cams, cement-mill gears, certain liner plates, coke chute troughs, coal breakers, coke crusher plates, concaves in limestone crushers, crusher rolls, grizzly disks (or Modified WH), impellers for brick-grog, liner plates for fans which move abrasive material (or Modified WH), log-washer paddles, mine car wheels, mixer tips for mixing asphalt and aggregate, rolls and rollers, sprockets, stamp-mill dies and shoes, and toggle plates.

STANDARD WH AND MODIFIED WH: Brick molds, crusher jaws, pug-mill knives, liners and segments, pulverizing hammers, ball liner plates, chute plates, clinker chutes, crusher rolls, tube-mill liners, augers, scrapers, ash pans, chutes, coke crusher segments, disk pulverizers, grizzly disks, sand and sludge pumps, blades, muller tires and rolls, rail-mill header guides, rolling mill guides and wire mill guides.

CORROSION-RESISTING TYPES:

TYPE CB: Acid pans, kettles, pumps, valves, fittings, evaporaters, condensers, retorts, stills. This material is used widely in oil refineries for pumps, pistons, bubble caps, tube supports, down-flow pipes and baffles.

TYPE CB3: Pumps, valves, fittings and other parts exposed to concentrated sulphuric acid.

TYPE KC: Evaporators, pots, carbonators, causticizers, fittings, valves, pumps.

FABRICATION

MACHINABILITY:

Machinability is not the same for the various types of Meehanite. The Dalcher comparative rating is a simple test performed with a device set up on a drill press permitting cutting-tool pressures to be measured in pounds. The lower the tool pressure, the better the machinability. Comparative ratings made by this method are tabulated in the following:

Material	Dalcher Rating (tool pressure-pounds)
Low-carbon steel castings	70
Gun Iron	58
High Strength Alloy Cast Iron (over 50,000 psi tensile str.)	67
Soft Gray Iron (under 30,000 psi tensile str.)	41
Meehanite Type GE (over 32,000 psi tensile str.)	38
Meehanite Type GA (over 50,000 psi tensile str.)	48

WELDING AND BRAZING:

Meehanite castings may be welded by means of the electric arc, using a steel or alloy rod, or special cast iron rod; or by gas, using a cast iron, Meehanite or bronze rod.

ELECTRIC WELDING: This may be done with either a bare or suitably coated steel or cast-iron electrode. Nickel and copper alloy rods and composite metal rods sometimes find favor with operators. Careful peening and cleaning of each deposited bead are necessary.

GAS WELDING: Preheating of the casting, or that part of the casting to be welded, to a dull red heat is recommended. A neutral to carburizing flame is preferred and the walls of the "V" should be fused to form a pool, the metal from the rod being transferred to the pool by rubbing and melting action. Under no condition should the rod be dipped into the pool. Use of flux is necessary. In bronze welding or brazing, the lower melting point of the bronze rod should be considered. Overheating must be avoided and fluxing conducted carefully.

HEAT TREATMENTS

(Following data are general. For specific recommendations it is suggested the supplying foundry be consulted)

Heat treatment to which Meehanite castings may be subjected can be divided into the following classifications:

1. Heat treatment for stress relief
2. Annealing for improved machinability
3. Conventional quench and draw for hardness, strength and toughness
4. Austempering or interrupted-quench treatments to promote improved hardness and toughness
5. Martempering to promote hardness without cracking
6. Local or surface hardening.

HEAT TREATMENT for STRESS RELIEF: Temperature and time of the treatment depend upon the type of Meehanite used and the size and form of the casting.

The higher-strength types require a somewhat higher temperature than the medium-strength types.

Recommended Temperatures

Type	Temperature (deg F)
GE, GD	950 to 1000
GC, GB	1050 to 1100
GA, GM	110 to 1150

(Continued on next page)

HEAT TREATMENTS (cont'd)

Castings are held at temperature long enough for the heat to penetrate all sections uniformly. For complex castings the time may vary from two to five hours if all internal strain is to be removed. Castings then are subjected to slow cooling.

ANNEALING FOR IMPROVED MACHINABILITY: This treatment is required only in unusual cases. Two kinds of annealing are used: Low-temperature and high-temperature. In the first, heat is held to just below the critical temperature, and in the second, heat is held to just above the critical temperature. Low-temperature annealing improves machinability without materially affecting hardness, but it may cause a loss in strength of about ten per cent. High-temperature annealing may also cause loss of both strength and hardness if annealing time is excessive. Annealing temperatures vary according to the type of Meehanite as follows:

Type	Low-Temperature Anneal (deg F)	High-Temperature Anneal (deg F)
GE, GD	1220 to 1260	1550
GC, GB	1230 to 1270	1570
GA, GM	1250 to 1290	1580

Heating time never exceeds one hour per inch of casting section and is followed by slow cooling.

QUENCHING FOR HARDNESS: High-strength types GM, GA and GB are comparable to carbon steel in their response to hardening by quenching in water or oil from above the critical change temperature. Where a type GA casting is required to be full-hard but with hardening stresses removed, drawing at 400 F after quenching is recommended. Where maximum strength and toughness are required of types GM and GA, drawing at 730 to 750 F for from one to four hours is recommended, and tensile strength above 75,000 psi will result. Where improved wearing properties are required but machining is necessary, castings are quenched at from 1575 to 1600 F and drawn at from 1050 to 1100 F for one to two hours. This treatment gives brinell hardness values from 290 to 321. Meehanite so treated has proved successful in many applications where combined uniformity, strength, toughness and wear resistance are of paramount importance.

AUSTEMPERING TO HARDEN: This treatment is effective only in small castings where it increases markedly the tensile strength and hardness without loss of toughness. The casting is heated to 1575 F and held there until uniformly heated. It is then quickly transferred to a liquid salt or metal bath held at the predetermined austempering temperature and maintained at this temperature for about 30 minutes. The casting is then cooled in air. Used where the conventional water or oil quench may result in cracking, austempering may be conducted at 600 F to 750 F. Where it is desired to increase toughness or resistance to shock with a slight increase in tensile strength, austempering may be conducted at 850 F.

MARTEMPERING TREATMENT: The casting is heated to 1575 F and quenched in a molten salt bath at approximately 400 F to 500 F. It remains in the salt bath only one or two minutes and then is withdrawn and cooled in air. Another procedure, recommended for heavier castings, is quenching direct from the hardening temperature of 1575 F in water covered with one-inch of oil. The casting is quickly withdrawn from the quenching bath when it reaches a temperature of about 500 F and immediately placed in a salt bath at 400 F. It is held in the salt bath until all sections become equalized in temperature and then is withdrawn and cooled in air. This treatment is particularly useful where an intricate casting has to be hardened and cracking may occur if the conventional oil or water-quench treatment were used. After martempering, a low-temperature draw may be used to further minimize any tendency toward cracking. Tensile properties should be comparable to those obtained with the ordinary quench, but increased toughness may result.

FLAME HARDENING: Castings may be hardened on the surface or locally by torch heating followed by rapid cooling. This process employs an oxyacetylene flame directed to impinge against the surface to be hardened. Rapid cooling is effected by contact with a suitable quenching medium (usually water) immediately after heating. The zone of maximum surface hardness obtained usually is one-half to three-quarters of the total depth of the case and is file hard. Points to bear in mind when designing castings for flame hardening are:

1. Extra foundry stock is desirable on light castings to take care of warpage and cleanup.
2. Holes cause difficulty and, if necessary, should be countersunk and the distance between the edge of the casting and the outside of the holes should always be over one-quarter inch.
3. Avoid designs which involve sudden changes of heavy and light sections. Use fillets generously.
4. Specify whether full hardness is necessary at the extreme ends of the hardened surface.
5. Wall sections and ribs adjoining a hardened surface should not be less than one-half inch thick.

RESISTANCE TO CORROSION

While no type of Meehanite is a thoroughly acid-resisting material in the same sense as platinum, lead, stainless steels, etc., the following are some of the chemicals that can and have been handled successfully:

Alkaline water, ammonium chloride, barium nitrate, benzine, bichloride of mercury, caustic potash solution, carbolic acid, carbon tetrachloride, calcium chlorate, caustic soda, coal-tar oil, cyanide of potassium, cellulose, certain fatty acids, gasoline, hydrofluoric acid, magnesium acid sulphate, naphtha, petroleum, 3% salt brine, sea water, sewage, soap liquor, marsh gas, sulphuric acid (very dilute), sulphuric acid (fuming), sulphuric acid gases, turpentine oil and vegetable oil.

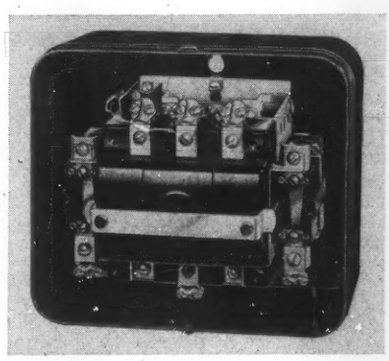
MATERIAL DESIGNATIONS

The only standard specifications which are in any sense parallel to the various types of Meehanite are: Type GA—ASTM Class 50; Type GC—ASTM Class 40; and Type GE—ASTM Class 30.

new parts and materials

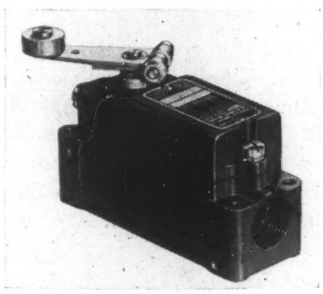
Magnetic Starter

MAGNETIC MOTOR STARTER, recently developed, utilizes a right-angle moving mechanism balanced to provide full use of magnet power without lifting extra weight. Fifteen-pound magnet pull is multiplied by the mechanism to give an effective force of 25 lb at contacts. Contact thus requires only 8.5 watts when closed and 75 watts on current inrush. The starter is designed for straight-through wiring with all line wires connected at one end and load wires at the other. The compact mechanism gives adequate wiring room in box and saves mounting



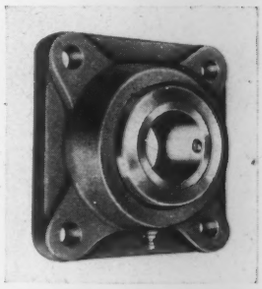
space when installed. Type RA Size 2 starter is designed in styles to cover voltages from 110 to 550 in 1 to 3 phases for controlling motors up to 25 horsepower. Enclosures measure 9⅛ by 8⅛ by 5 inches. Manufacturer is the Arrow-Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford, Conn.

Snap-Type Limit Switch



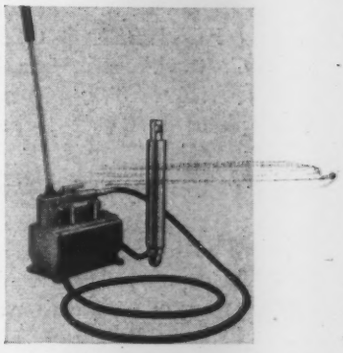
PRECISION SNAP-TYPE limit switch is said to have high electrical rating, long mechanical life and minimum size, all made possible through the use of small, husky self-contained contact mechanism mounted in a gasketed die-cast enclosure. Surface and flush mounting arrangements are available in the switch and can be obtained with either roller-arm or push-rod operated mechanisms. Roller arm types require only 5 degrees travel for operation and are provided with as much as 25 degrees overtravel in either direction. Return springs are easily reversed for either clockwise or counter-clockwise motion of lever and operating arms are available in lengths from ⅞ to 3 inches with standard hardened-steel rollers ⅝-inch in diameter and ¼-inch wide. Special rollers can be furnished. Manufacturer is the Square D Co., Industrial Controller Division, 4041 North Richards St., Milwaukee 12. Limit switch is the Type AW Class 9007.

Ball Bearing Flange Unit



FULLY SELF-ALIGNING bearing known as the SC ball bearing flange bearing, recently developed, is fully self-aligning and is suitable for mounting against vertical or horizontal frames and supports. The bearing is a deep-groove precision type with long inner race and improved labyrinth seals. Back face of housing is machined. Filling slots are at back, providing additional protection against external dust and dirt. Bearing is an addition to a complete line of ball bearings available in pillow blocks, hanger bearings, take-up and cylindrical units from the same source. Manufacturer is the Dodge Manufacturing Corp., Mishawaka, Ind.

Hydraulic Hand Pump



ALUMINUM-HOUSED, hand-operated hydraulic pump has been brought out by Industrial Hydraulics Corp., Painesville, Ohio. Both pump housing and reservoir are cast aluminum, substantially reducing weight of the unit. Pump is available with plungers ½, ¾ and 15/16 inches in diameter, and is designed for two-way action. Two models are available: Model PH3A incorporating a one gallon reservoir, and Model PH4 consisting of pump assembly only.

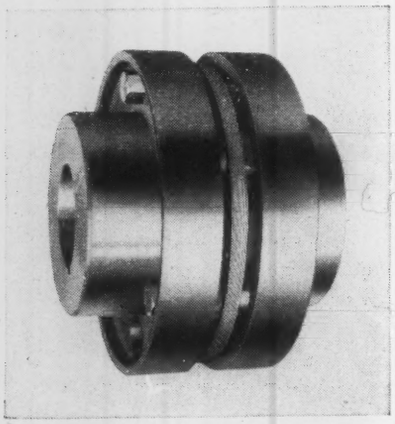
Welding Electrodes

ALL-POSITION mild-steel electrode named Airco No. 312 has been placed on the market by Air Reduction Sales Co., 60 E. 42nd St., New York. The electrode, designed to prevent underbead cracking in welding of

hardenable steels, is suitable for low-alloy, high-tensile steels, free-machining steels, and cold-rolled steels. Electrode is also suitable for welding which is to be followed by vitreous-enameling.

Machine Couplings

SINGLE TYPE coupling, designed to take care of angular misalignment is now available for use with outboard bearings or their equivalent. Coupling is self-aligning, self-supporting type and maintains an exact interrelationship of connecting shafts. It is so designed that it will



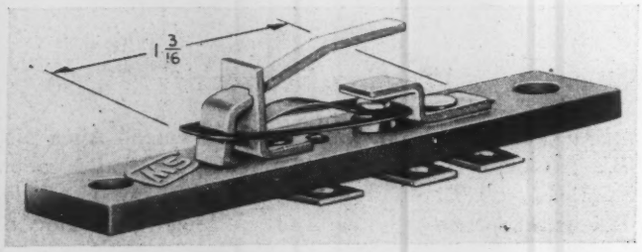
support the armature or rotor of motors and generators, thus eliminating one bearing. The ST Type coupling is available in 15 models to accommodate shafts from 1⅝ to 8 inches in diameter. It will handle 0.4 to 318 hp at 100 rpm. Manufacturer is the Thomas Flexible Coupling Co., Warren, Pa.

Stainless-Clad Steel

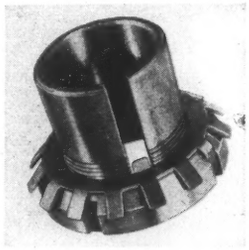
NOW BEING OFFERED by the Lukens Steel Co., Coatesville, Pa., is a line of stainless-clad steel in types 304, 316, 347, 410 and 430. The steel is furnished in plates 3/16 to 3 inches thick and up to 162 inches wide.

Unhoused Snap-Action Switches

SKELETON TYPE precision snap-action switches now being offered are particularly adapted to actuation by rotating or sliding cams. The Type SK switches are single units available in normally-open, normally-closed, or double-throw circuit arrangement. The switch element, measuring 1 3/16-inches long, is mounted on a laminated-phenolic base. Tentative rating of the unit is 10 amperes at 250 volts ac, operating force is 3 to 8 oz and release force 2½ to 7 oz. Movement differential of the unit is 0.008 to 0.022-inch and overtravel is 1/32-inch minimum and 1/16-inch nominal. Manufacturer is Micro Switch, Freeport, Ill.

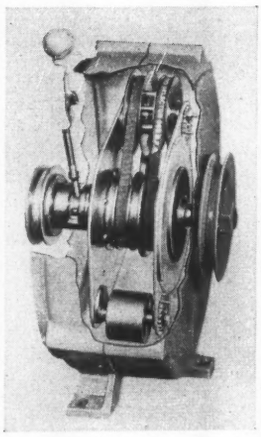


Bearing Adapter



BEARING ADAPTERS consisting of a locknut, a lockwasher and a sleeve are designed to hold permanently the inner race of tapered-bore bearings to a straight shaft during rotation. The new series of adapters are available in sizes to fit shafts of 1 3/16, 1 7/16, 1 15/16, and 2 3/16-inch diameters. By removing threaded nut from the sleeve, the shaft may be easily removed from bearing and when nut is removed, bearing, sleeve, lockwasher and shaft are disassembled without difficulty. Manufacturer is Standard Locknut and Lockwasher, Inc., 311 North Capitol Ave., Indianapolis 4, Ind.

Variable-Speed Drive



IMPROVED planetary infinite-ratio Speed Selector similar to that announced previously in this section is designed as an independently-mounted transmission. Speed Selector employs planetary motion with four variable-pitch sheaves and two standard V-belts. It provides any speed from zero to 800 rpm at constant torque from a constant-speed power source. New model is available in ½, 1 and 2-hp output, is simple and sturdy in construction. Optional V-belt or flexible coupling input and output make the selector easily adaptable for mounting in any position. Major advantages claimed for the unit are: Infinite ratio, quick speed changes, smooth operation, high efficiency, adaptability, simplicity, and ease of installation. Manufacturer is the B. F. Goodrich Co., Akron, Ohio.

Cartridge Filters

REPLACEABLE-TYPE cartridge filters in series of ten sizes and three models have been developed by Bowser, Inc., Fort Wayne, Ind. Filters contain resin-impregnated cellulose elements which are said to remove particles as small as one micron at viscosities up to 600 Saybolt sec-

From **A** *brasives*

to **Z** *ithers*

Every Manufacturer *can profit by this Complete* BEARING SERVICE

Factory trained sales engineers are located in eighteen principal industrial centers . . . ready to serve you *now!*

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JOHNSON BRONZE COMPANY

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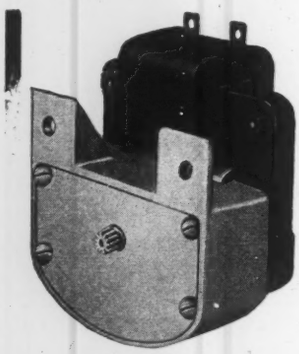
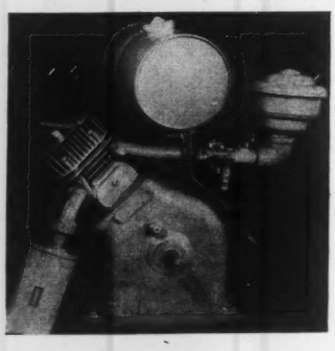
onds and temperatures as high as 350 F. For a viscosity of 50 to 60 Saybolt seconds, filters have a capacity range varying from 2/5 to 300 gallons per hour with filtering areas of from 0.2 to 100 sq. ft. The larger models are available in four sizes: 8, 25, 50 and 100 sq. ft. Overall dimensions range from 19 inches to 56 inches in height and 12½ to 30½ inches in diameter. Pipe connections from 2 to 4 inches in size are provided.

Fractional-Horsepower Motor



FRACTIONAL - HORSEPOWER synchronous electric motor having a torque of 10 ounce-inches at one rpm is being offered by Kurman Electronics Corp., 35-18 37th St., Long Island City 1, N. Y. Motor is designed to operate on 125 volts, 60 cycles, and has a loaded-shaft speed of 4 rpm. Motors can be furnished for voltage from 1 to 250 and frequencies from 25 to 120. Direction of rotation may be set either clockwise or counter-clockwise. Overall size is 2 by 2⅜ by 1¼ inches. Motor weighs approximately 9 oz.

Single-Cylinder Engine



AIR-COOLED, single-cylinder gasoline engine developing in excess of 4 hp has recently been developed. Engine uses an integral half-speed drive permitting full horsepower output at one-half normal crankshaft speed. Available as an integral assembly with standard crankcase, is a clutch and reverse-gear assembly for convenient installation in marine and farm equipment without the necessity of supplementary transmission, reduction gears, clutches, etc. Engine has forged-aluminum connecting rods, cast-aluminum-alloy cylinder head, permanent-mold cast-aluminum piston with a 2⅝-inch bore and 2⅝-inch stroke. Crankshaft and camshaft and valves are steel. Manufacturer is Ellinwood Industries, Los Angeles, Calif.

Shielded-Arc Electrodes

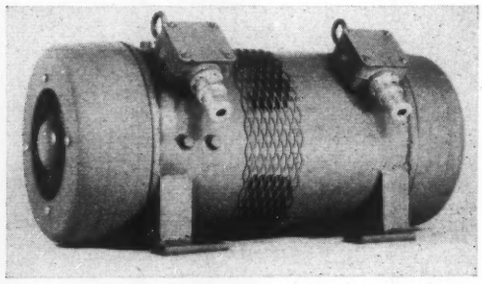
SHIELDED-ARC type, coated electrodes are now available from the Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 4, for the five grades of aluminum-bronze electrodes produced by the company. The new electrodes are said to strike easily and not to snuff-out on ac welding. Spatter loss has been reduced to a minimum. They are recommended for use in welding cast irons, malleable irons, aluminum bronzes, silicon bronzes and dissimilar metals with direct-current generators and ac current transformers having a 75 to 85 open-circuit voltage.

Pressure Regulator

ADJUSTABLE to function in systems operating at pressures from 10 to 150 psi is a new pressure regulator now being marketed by A. Schrader's Son, Division of Scovill Mfg. Co. Inc., Brooklyn 17. With the regulator, air is delivered at predetermined pressure, saving wear and tear on the compressor and reducing air costs. Pressure at the equipment is kept constant regardless of possible wide variations in the system pressure. Regulator is furnished with a pressure gage.

Motor-Generator Set

HIGH-FREQUENCY motor-generator set producing 1000 volt-amperes at 115 volts ac now is being marketed by the Kato Engineering Co., Mankato, Minn. Designed to operate from 75 volts dc power, the set has a voltage



regulation approximating 10 per cent at 60 per cent power factor, and 7 per cent at unity power factor. Approximate efficiency is 45 to 50 per cent at unity power factor. Designed for continuous operation, the unit has four poles and operates at 3440 rpm. It measures approximately 23 11/16 inches long, 12 3/8 inches wide, 13 3/8 inches high and weighs 210 lb.

Elapsed-Time Indicator

PRODUCTION has recently been announced of an elapsed-time indicator for operation on 115 volts, ac. Operation time from 0 to 10,000 hours may be indicated with the device which is known as model HM3. Hermetically sealed, the indicator is said to be designed not only for production maintenance operation in general industry but particularly in chemical and allied industry. The manufacturer is the Marion Electrical Instrument Co., Manchester, N. H.

Flexible Metal Tubing

FLEXIBLE gas tubing known as Carbo-Flex is now available in sizes ½ and ¾ inches. The tubing comes equipped with a Wiggins quick coupling at both ends, is standard in lengths of one to six feet and is available

THEY'RE MAKING WHEELS

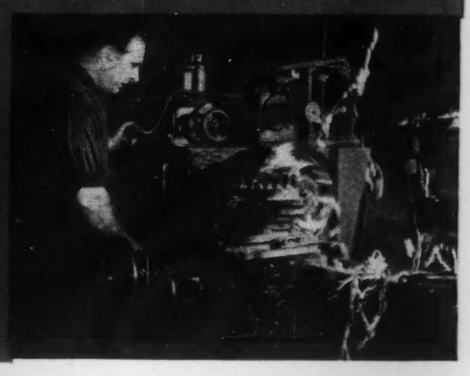
One-third lighter with MAGNESIUM

Magnesium lightness is modern, functional lightness—plus shock-resistant strength! Here's further proof of this: Most of America's small plane manufacturers specify magnesium wheels. That's because magnesium wheels are just about one-third lighter, yet they give dependable performance—the kind of performance that magnesium is bringing to diversified products in many industries.

MAGNESIUM DIE CASTINGS . . . CUT PRODUCTION TIME

These 6.00 by 6 wheels are die-cast in halves weighing only 1.6 pounds. Manufactured by Goodyear, Akron, Ohio, they withstand 1,200 pounds or more of static load, exceeding design requirements.

Die-casting with magnesium reduces machining on these wheels to a minimum. With magnesium, necessary machining is easily and quickly done. Magnesium saves production time and keeps cost of finished products down.



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Magnesium Lightness too!

Dow supplies magnesium and its alloys in all forms. Call on Dow for technical information on magnesium.

DOW

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

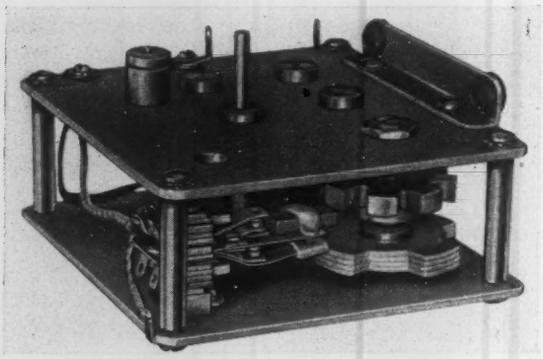
New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

Dow Chemical of Canada, Limited, Toronto, Ontario

in sizes ¼, ⅜, ½, ⅝, ¾, 1 and 1¼ inches. The tubing has heat and acid resistant neoprene lining, while outside is available in stainless steel, Monel, bronze, brass, copper, aluminum or other metals. Made of copper or aluminum, tubing withstands up to 600 psi hydraulic and air pressure. When made of such materials as stainless steel, galvanized steel, Monel, brass, etc., it withstands up to 1200 psi. Manufacturer is the Carbo-Flex Hose Co., 5452 Vineland Ave., North Hollywood, Cal.

Constant-Speed DC Motor

CONSTANT-SPEED direct-current motor designed around polarized magnetic drive of a vibrating reed, has been developed by the Amglo Corp., 4234 Lincoln Ave.,



Chicago 18. The motor is self starting, gains full speed almost instantly and is said to have high efficiency. Tested current consumption has varied from 0.06 to 1 watt. The motors are available for use at 3, 6, 12, 24, 32, or 110 volts.

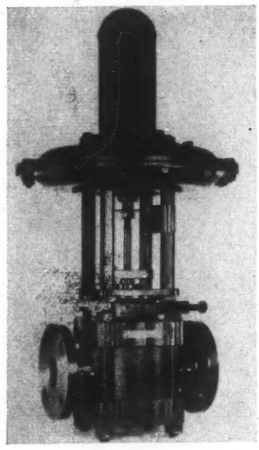
Flexible Tubing

SELF-EXTENDING, non-collapsible retractable tubing has been placed on the market by the Warner Brothers Co., Bridgeport 1, Conn. The tubing, known as Spiratube, utilizes a continuous helical spring to form the core. The fabric is then stitched so that there are no exposed wires creating ridges to impede air.

Forged Tubing Fittings

NEW, IMPROVED brass fittings for connecting copper, steel, aluminum and other thin-wall metal tubing have been announced by The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7. New fittings have forged bodies, are available in elbows and tees and incorporate Dryseal pipe threads. Other pipe fittings include: Imperial compresion, flared, Hi-Duty, inverted flared and Flex-Tube fittings. Fittings are said to be over 80 per cent stronger and 60 per cent tougher than the usual types. Close-grained structure of the metal in fittings assures against porosity and blow holes.

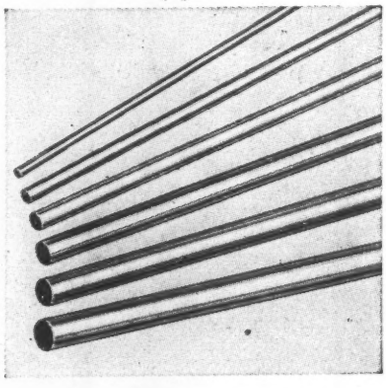
Diaphragm Motor Valve



NEW TYPE diaphragm motor valve construction has been announced by the Fischer & Porter Co., Hatboro, Pa. Known as the Valvrator Line the units are characterized by dished-bonnet construction with flush-seated bodies and through bolts. Design results in a compact unit with low weight and simplified cleanout characteristics. Valve is made in only 150 psi construction, in sizes from ¼ to 1 inch, screwed, and from 1 to 3 inch, flanged. Body materials such as iron, bronze, stainless steel, lead, rubber and porcelain are available on demand to suit design requirements.

Tungsten Carbide Extruded Bars

LINE OF solid Kennametal extruded rounds available in two tungsten carbide grades, KE5 and KE7, with a Rockwell hardness of 89 and 91, respectively, are now available from Kennametal, Inc., Latrobe, Pa. Rounds,

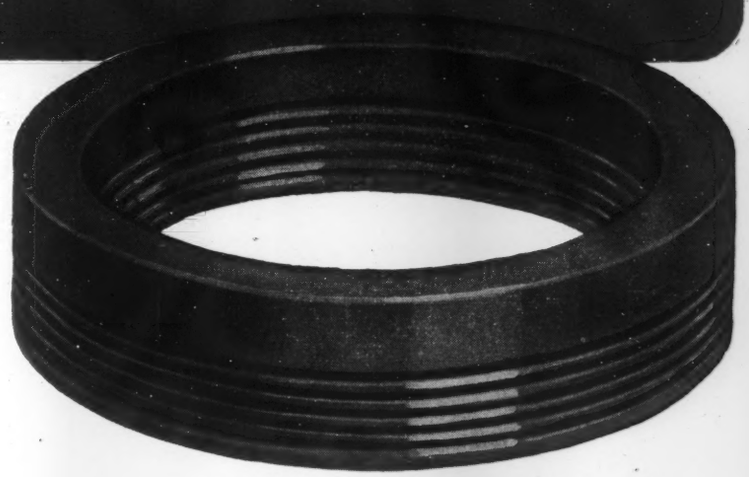


which are suitable for such applications as guides, feeding fingers for automatic machines, rollers, etc., are available in either rough, extruded or centerless-ground rod in diameters from 1/32 to ¼ of an inch and in standard lengths in even inches from 1 to 10.

Roller Bearing Seals

DEVELOPED to meet universal need for a housing seal, effectively retaining lubricants and keeping out dirt, the new Z Seal has been announced by the Shafer Bearing Corp., 1412 W. Washington Blvd., Chicago 7. Consisting of five parts, seal element fits on an extension of the

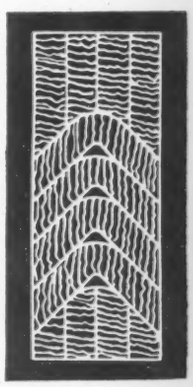
Why we call them "ENGINEERED" packings



Houghton's hydraulic packings are built for the specific job . . . a la carte, so to speak, and not supplied on a "take-it-or-leave-it" basis. Here's an example:

An equipment manufacturer had continuous trouble due to poor sealing and oil leakage, which no previous packings had solved. The engineer came to Houghton for suggestions.

We drew up a simple design calling for VIM resin-impregnated "V" packings, four to the set (see above) with top and bottom support rings of laminated leather. It worked: no leakage, no failures, lower frictional resistance, permitting more rapid operation of high-speed air-hydraulic units made by that company.



VIM "exceeded every expectation," reports the manufacturer. Which is just another of a long line of victories for VIM Packings and Houghton engineering service.

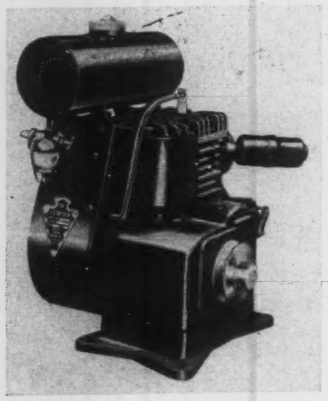
Our packing line is complete, including leather, synthetic rubber and "O" rings, covering the full range of pressures and temperatures. For advice, and for packings, write E. F. HOUGHTON & CO., 303 W. Lehigh Avenue, Phila. 33, Pa.

HOUGHTON'S
VIM LEATHER and VIX-SYN PACKINGS

inner bearing race and with minimum running clearance provides an almost frictionless seal. Element is held under moderate tension yet is permitted to float radially thus correcting for radial displacement from any cause. Entire unit is easily removed and dissembled into component parts.

Single-Cylinder Gasoline Engine

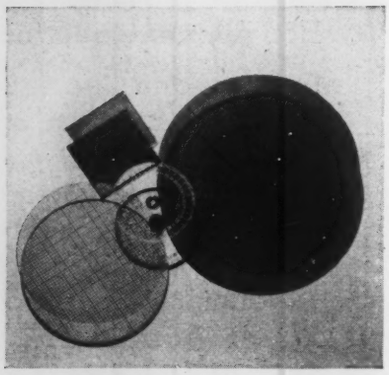
FOUR-CYCLE, air-cooled, single-cylinder gasoline engine recently announced produces 1 to ½ hp at 2000 to 3600 rpm. The engine, which has a 6:1 speed reduction, has a 2-inch bore, 1⅞-inch stroke giving a displacement of



5.89 cubic inches. The engine weighs 40 lb, uses steel and cast iron for all major parts excepting the connecting rod. Manufacturer is the Clinton Machine Co., Clinton, Mich.

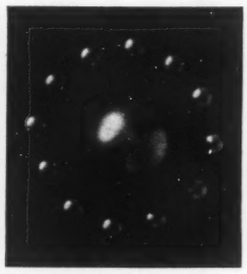
Engraved Dials

PRECISION engraved dials and scales are now available from the American Precision Dial Co., 93 Massachusetts Ave., Boston 15. Made of plastic, metal or glass,



the scales can be engraved with circles up to 20 inches in diameter and with as many as 6400 radial graduations accurate to two minutes in 360 degrees. Straight lines up to 15 feet in length may be engraved with little deviation from the true. Cross-section engraving as fine as 500 lines per inch may be obtained, and for applications where parallax is to be avoided, precisely matched engraving is furnished on both sides of material up to ½-inch thick.

Tungsten-Carbide Balls



TUNGSTEN - CARBIDE balls are now available in any size and with any desired degree of dimensional accuracy from Industrial Tectonics, Ann Arbor, Mich. The balls are said to be useful in burnishing and polishing operations and because of their hardness and great corrosion resistance, to be particularly suited for use in check valves. Balls are also available with holes for permanent attachment of wires and cables. High compressive strength of the balls in addition to their hardness is said to make them highly desirable for special bearings and antifriction mountings.

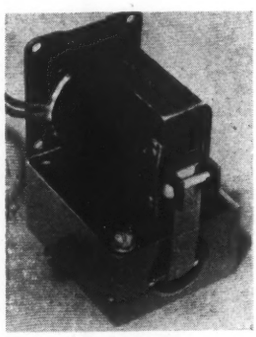
Rubber-Tired Wheels

LINE OF rubber-tired steel wheels for mobile industrial equipment is now being offered by the Palmer Mfg. Co., 8115 Clinton Rd., Cleveland. Wheels are characterized by a specially-designed patented wheel-mounting system employing no cross axle. They are available in 5½ and 8-inch diameters with ⅜ and ½-inch bushings.

Rubber Adhesive

DEVELOPED by the United States Rubber Co., Rockefeller Center, N. Y., is a new synthetic adhesive for use in conjunction with textile fibers to produce flock. The new product, known as flocking adhesive M-6177, may be sprayed or brushed on wood, metal, glass and other surfaces and is said to have longer life and more flexibility than base-coat adhesives currently used. Adhesives can be dyed any color to match textile fibers.

Solenoid Two-Way Valve



INTRODUCED BY Electrol, Inc., Kingston, N. Y., is a complete 110 volt ac solenoid two-way valve for use on all types of machines where continuous duty is desired. Unit accommodates operating pressures from 0 to 1500 psi and higher, is primarily for use with oil but can be adapted for use with other fluids. Valve is supplied in four NPT pipe sizes—⅛, ¼, ⅜ and ½-inch. Housing is heat-treated aluminum alloy while poppet and seat are hardened and ground steel forming a balancing valve that assures long

J&L ELECTRICWELD STEEL TUBING IS AVAILABLE TO YOU NOW

Manufacturers are taking advantage of the fact that J&L Electricweld Tubing is now available for early delivery. Design and production engineers know that the great strength of this light tubular section permits reduction in weight and bulk with saving in costs of material. It also can be fabricated economically.

For forming operations, the uniformity of cross-section and wall thickness of Electricweld Tubing makes it possible for products to conform to close tolerance limits. Electricweld Tubing can be altered in cross-section by any number of processes to meet requirements of design. It bends easily in all directions and can be readily joined by mechanical or welding methods.

Beauty and sales appeal in finished products are aided by the smooth, uniform surface of J&L Electricweld Tubing. It provides an ideal base for electro-plating, enameling, and painting. These finishes can be applied with a minimum of surface preparation.

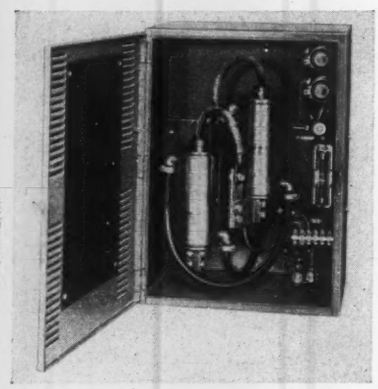
For information on delivery of J&L Electricweld Tubing to increase your production and improve your products, contact the nearest sales office listed below.

JONES & LAUGHLIN STEEL CORPORATION
PITTSBURGH

SALES OFFICES: Atlanta • Baltimore • Boston • Buffalo • Chicago • Cincinnati • Cleveland Columbus • Dallas • Denver • Detroit • Harrisburg • Houston • Indianapolis • Los Angeles • Memphis Milwaukee • Minneapolis • New Haven • New Orleans • New York • N. Kansas City Philadelphia • Pittsburgh • St. Louis • San Francisco • Seattle • South Bend • Syracuse Toledo • Tulsa • Washington

and reliable service. Heavy duty 110-volt 60-cycle solenoid is mounted on top of valve housing with motion transmitted to valve plunger by lever.

Electronic Contactors

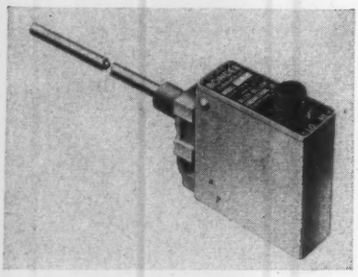


COMPLETE new line of electronic contactors using ignitron tubes has been placed on the market by the Square D Co., Industrial Controller Div., 4041 N. Richards St., Milwaukee 12. The new contactors are offered to operate over a wide range of weld times and duty cycles. Design of the new Class 8990 electronic contactors provides increased wiring space with power connections made near center of enclosure. All control elements are grouped on right-hand side away from tubes, and cabinets are of heavy sheet steel with ventilating louvers in the door.

Blower Wheel

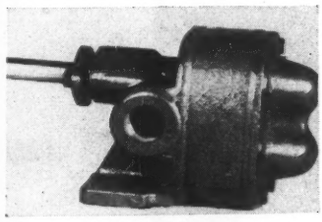
NEW IMPROVED blower wheel with outstanding strength and efficiency in operation has been announced by Utility Appliance Corp., Los Angeles. The new wheel is of resistance-welded construction with blades stamped from continuous steel strip. Air delivery ratings are certified for all sizes and are derived from performance tests. Dual drive with hubs at each side distributes wheel weight close to the bearings reducing shaft and bearing loads and permitting increased power input necessary for higher wheel speeds.

Thermostat



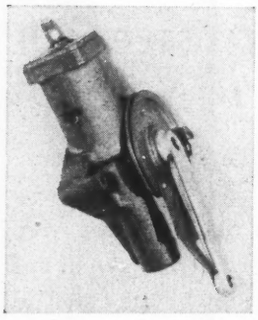
DEVELOPED by the Alloy Bellows Engineering Co., 935 Greyton Rd., Cleveland, is a new thermostat for use in close temperature control of fluids. Known as "Bondee", it is sensitive to operation within plus or minus ½ degree F, and will operate from off to on within one degree F change. Construction is sturdy with cast body, rod and tube thermal elements, and stainless pins and springs. Having a total range from sub-zero to 250F, the instrument is provided with an adjusting knob having a 30-degree range. Thermostat has a 10-ampere capacity at 125 volts and 5 amperes at 250 volts ac. Standard unit is provided with a thermal element 16 inches long.

Rotary Pump



NEW LINE of general-service rotary pumps designed for durability under severest service conditions have been introduced by Worthington Pump and Machinery Corp., Harrison, N. J. Six sizes of the pump are available in various mountings, for capacities up to 51 gpm and 100 psi. Design features of the unit include four-bearing construction and special herringbone rotors. Built-in pressure lubrication eliminates all external lubrication problems. Models are available for foot or flange mounting and with adjustable stuffing boxes and mechanical seals. All models are suitable for direct coupling to electric motors of any make.

Radial Hydraulic Actuators



TRANSLATING the linear motion of a cylinder piston into 200 degree rotary motion of the lever, a new hydraulic radial actuator developed by Adel Precision Products Corp., 10777 Van Owen St., Burbank, Calif., operates from 300 psi hydraulic pressure and produces 700 inch-pounds of shaft torque. Body of the actuator is high-strength cast-aluminum alloy and piston-shaft rack and pinion are of alloy steel. Fluid line connections are made by means of ⅛-inch NPT holes provided to receive standard hydraulic line fittings. Unit may be assembled for right or left hand installation and shaft may be placed in any of 28 different positions relative to a full circle. A cable drum attached to the lever provides an alternate manual means for controlling the actuator movement.

New Welding Electrode

BRONZE welding electrode for the oxyacetylene process is now available from The Linde Air Products Co., 30 East 42nd St., New York 17. Known as Oxweld No. 25M, Patented Flux-Coated Rod, the new electrode is said to combine all the superior properties of Oxweld No. 25M bare rod with the advantage of fluxing. New rod is said to speed up welding operation and make it easier to produce welds of uniformly high quality.

Servomechanism

SERVO for remote indication or control has been developed by G. C. Wilson & Co., 2 North Passaic Ave., Chatham, N. J. Servomechanism consists of three components—torque unit, amplifier unit and control unit. Position of the shaft on the torque unit is controlled by the

SAVE POWER

in Inside Packed Pistons with J-M Moulded Cups

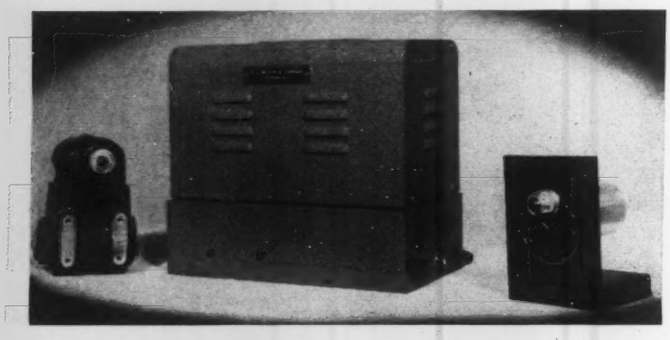
Machines designed to use J-M Moulded Packing Cups can often operate on less power—because these "custom-made" packings take the guesswork out of installation. They provide precision-fit, minimizing both friction and slippage. Under discharge pressure, each cup functions as a tight seal. But on the reverse stroke the special flexible lip relaxes, lowering friction and reducing the amount of power needed. Packing cups minimize the danger of high slippage or excessive tightness which may occur with conventional type packings.

If you manufacture or design any of the following types of equipment, write to Johns-Manville, Box 290, New York 16, N. Y. for complete information on J-M Moulded Packing Cups.

Reciprocating Pumps
Hydraulic Lifts
Hydraulic Jacks
Farm Machinery
Drilling & Boring Machinery
Air Brake Cylinders
Compressors
Governors
Power Shovels
Grease Guns
Air Chucks
Grinders
Valves (hydraulically operated)

JM PRODUCTS

Johns-Manville
PACKINGS & GASKETS



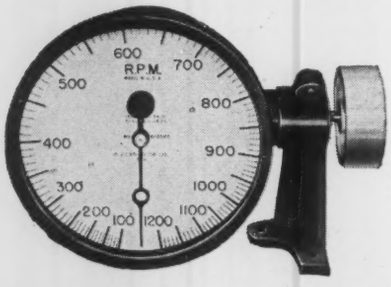
amplifier to correspond to the control unit signal. The system is sensitive to one per cent changes in the control unit, and requires approximately one ounce-inch of torque for operation, while the torque unit develops a maximum of 50 lb-ft of torque. Amplifier unit consists of three radio type vacuum tubes and associated equipment. System operates from 115-volt 60-cycle power.

Organic Finish

NOW BEING MANUFACTURED by the Watson-Standard Co., Pittsburgh, high-solid Vinylite finishes are available in clear and brilliant colors and can be applied by any method of metal finishing either before or after fabrication. Coatings are adaptable to baking and produce brilliant finishes that have outstanding durability on interior and exterior surfaces.

Stationary Tachometers

EXTREMELY free running, a new type tachometer can be driven by the friction of contact with a running thread. This tachometer is guaranteed to have an accuracy of ½ of one per cent in either direction of rotation. A centrifugal type, it has a range ratio up to 1 to 40, is adapted



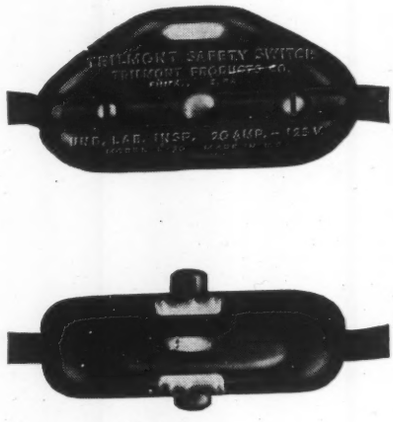
not only for high but also for very low speeds and is useful for heavy as well as light duty. Instrument has a dial measuring 6 inches in diameter, housing 2¾ inches deep and weighs 2¾ lb. Manufacturer is O. Zernickow Co., 15 Park Row, New York 7.

High-Strength Welding Alloy

WELDING ALLOY providing high-strength welds on ferrous and nonferrous metals at low melting points has been developed by Eutectic Welding Alloys Corp., 40 Worth St., New York 13. The alloy, which is obtainable in rod, wire, strip and powder form, may be applied in many of the usual ways and will give a weld shear strength of 120,000 psi. It melts at 1143 F and bonds at base metal temperatures of from 940 to 1120 F.

Safety Snap Switch

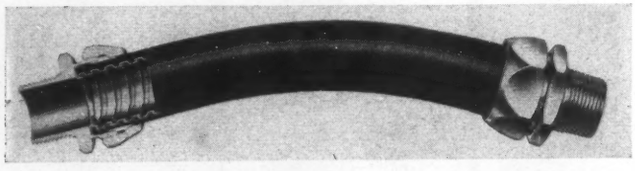
FEED-THROUGH cord switch embodying many electrical and mechanical features is announced by Trilmont Products Co., Walnut street at 24th, Philadelphia 3. While the outer dimensions are similar to ordinary light-duty feed-through cord switches, the internal unit is a double-pole single-throw push-through device, designed to operate satisfactorily on electrical apparatus rated to 2500 watts ac or dc, 125 or 250 volts. It carries the Underwriters'

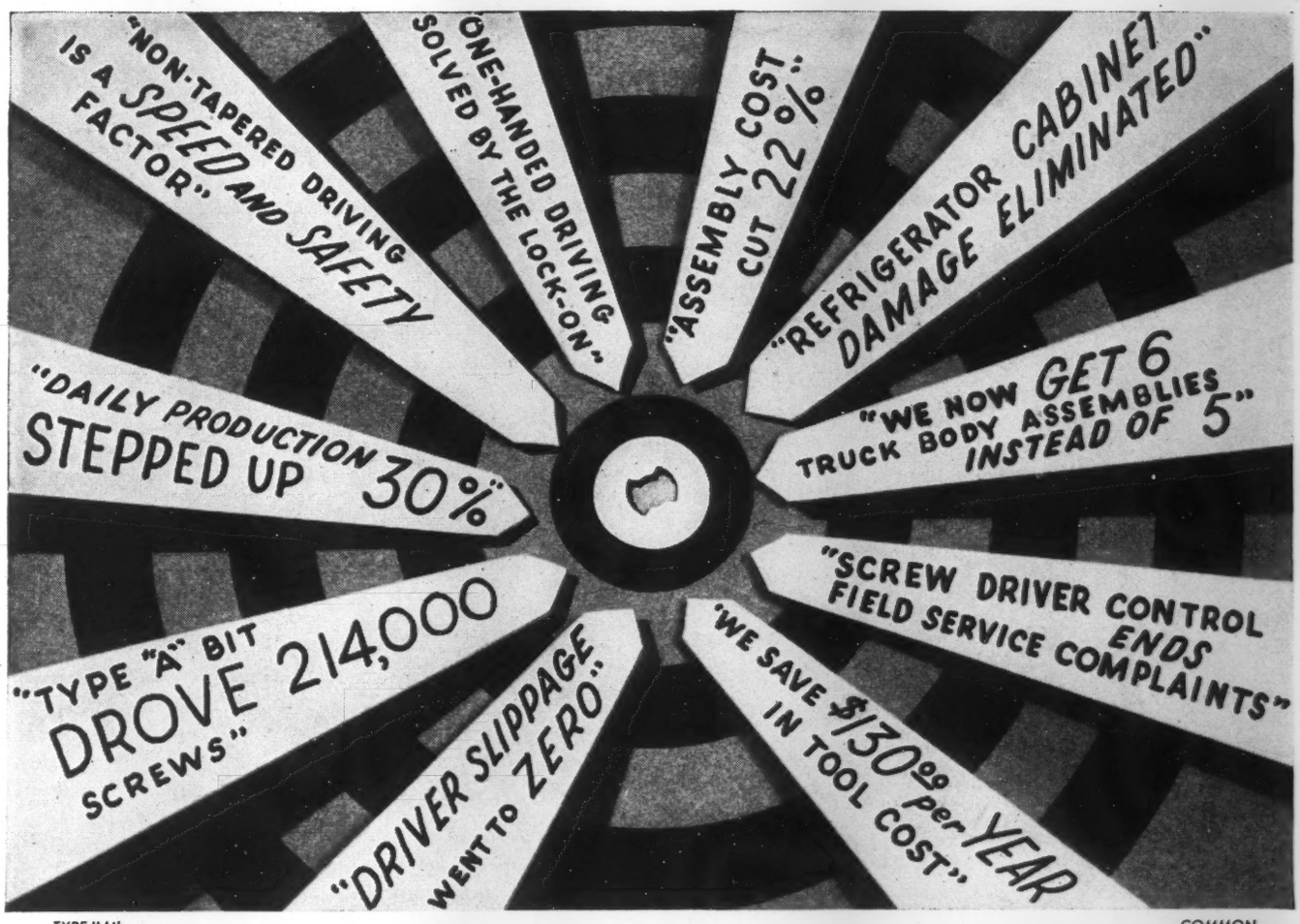


Listing of 20 amperes at 125 volts. The switch mechanism consists of fast snap-action over-the-center spring-controlled tapered shaft, operated by plastic pushbuttons. The tapered shaft passes through a plastic shorting bar, on which are mounted two silvered plates. Shorting bar moves the silvered plates into on or off position, thus making or breaking the power supply at four fixed silvered contacts.

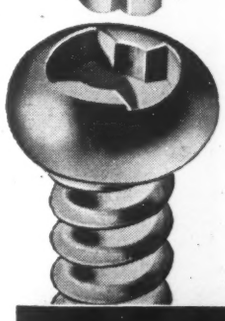
Synthetic-Covered Electric Conduit

SUITABLE for covering electrical wiring used on any type machine which may contact oil or moisture, a new conduit known as Sealtite has been announced by the American Metal Hose Branch of The American Brass Co., Waterbury 88, Conn. Conduit is made of a galvanized-steel flexible tubing covered with oil-proof synthetic material. Conduit fittings have standard pipe threads and are available in two types: Permanently attached or reattachable. The conduit is constructed to resist abrasion, withstand ordinary abuse, and is made in all standard sizes up to 2 inches ID.

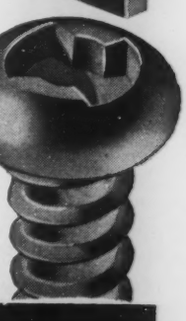




TYPE "A" ASSEMBLY BIT



COMMON SCREWDRIVER



What Say They?...

...The Users of CLUTCH HEAD SCREWS?

QUOTES LIKE THESE... direct from America's largest and busiest assembly lines, clearly point to CLUTCH HEAD Screws as a major factor

For Lower Cost from Stepped-up Production
For Greater Safety in Higher Speed Driving
For the Effortless Ease of Non-tapered Driving
For Freedom from the Hazard of Skid Damage
For Fractional Cost in Tool Maintenance
For Screwdriver Simplicity in Field Service

When operators of critical assembly lines credit Clutch Head . . . AND CLUTCH HEAD ONLY . . . with these definite advantages, this modern screw certainly merits your investigation. To enable you to make your own independent appraisal of these exclusive features, just send for package assortment of CLUTCH HEAD Screws, sample Type "A" Bit, and illustrated Brochure.

Note the rugged structure of this bit for longer service: the Center Pivot Column for automatic straight driving; its flat sides to match straight walls of the clutch for all-square contact and no ride-out. Its simple 60-second reconditioning reduces expense, time, and trouble to a minimum.

CLUTCH HEAD SCREWS

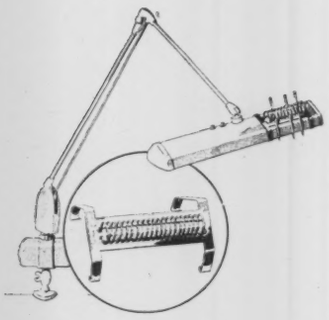
Test the perfect operation of CLUTCH HEADS with a common screwdriver which need only be reasonably accurate in width. Thickness of the blade is immaterial because of the roominess of the recess. This is the only modern screw thus *basically designed* for simplified field service.

UNITED SCREW AND BOLT CORPORATION

CLEVELAND 2 CHICAGO 8 NEW YORK 7

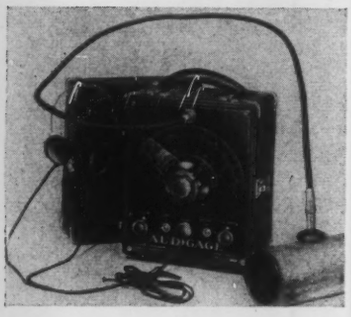
engineering dept equipment

Pencil Rack



RECENTLY DEVELOPED spring-clip rack for the support of drafting pencils, etc. has been designed specifically for use with the Dazor floating lamp. The unit, known as the Pencil Clipper, incorporates a spiral spring fixed to a mounting bracket. Bracket clips easily onto lamp placing pencils within visual and fingertip reach and eliminating search for strewn pencils under paper and drawings. Manufacturer is Morrison & Sons Co., P. O. Box 717, La Crosse, Wis.

Crystal-Type Thickness Gage

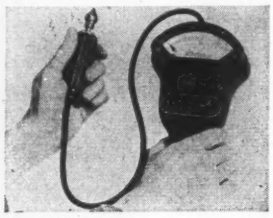


PORTABLE INSTRUMENT designed to measure from one side the thickness of many materials, including steel, has been developed by Branson Instruments, Inc., Joe's Hill Rd., Danbury, Conn. The instrument, known as the Audigage, utilizes a crystal-type gage head, powered by a frequency-modulated electronic oscillator. When the vibrating crystal is applied to a wall surface, mechanical resonance of the wall thickness can be produced directly below the crystal. Other information in addition to thickness is provided, such as: Kind of material, condition of reflecting surface, back-up liquids, etc. The gage can be applied to steel, aluminum, brass, copper, glass and other materials and covers a thickness range of from ⅛ to 12 inches.

Rectifying Electrical Probe

MINIATURE crystal rectifying probe now being made adapts the RCA VoltOhmyst and Chanalyst for high-frequency testing of circuits within the sensitivity ranges of these instruments. The new probe, known as Type MI-8263, employs a germanium crystal to rectify applied ac voltages, which are then measured by the dc circuit of the meter. The meter reading is proportional to the positive peak of the applied ac voltage and excellent linearity is obtained, even at the ends of the meter scale. The probe is constructed of durable insulated material, has a long narrow point and is reinforced at the end with a metal shield to eliminate capacity effects when held for testing. Manufacturer is the Radio Corp. of America, RCA Victor Division, Camden, N. J.

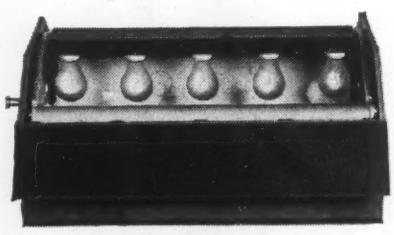
Hand Tachometer



HIGH-ACCURACY single-range tachometer recently developed has an accuracy of one per cent or better and has a speed measuring range of 110 to 210 rpm over full length of scale. The Type 25C tachometer has only one rotating part which is mounted in permanently-lubricated ball bearings. No gears or flexible shafts are employed. Head consists of a simple switch which changes the polarity of a reactance in a bridge circuit, assuring long life and accuracy. Other speed ranges available are from 10 to 10,000 rpm or higher where highest speed is about twice the lowest speed to be measured. The switch comes complete in carrying case with all necessary accessories including a one-foot circumference disk for measuring linear speeds direct in feet per minute. Manufacturer is the Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado.

Printer

NEW PHOTO PRINTER for blue or black-line prints is now being offered by Foster Sales Co., Royal Oak, Mich. The Foster printer makes prints in sizes up to 18 by 24 inches in less than five minutes. It operates with photo-flood bulbs, has a closed compartment for holding paper and is inexpensive in its cost and operation. The



printer is designed to supplement regular blue printing equipment in larger plants, and handles prints from paper or cloth tracings, printed or typewritten sheets or handwritten copy.

Wichita City Libr

Weld Penmetal Steelmesh

TO LIGHTWEIGHT METALS FOR HEAVY-DUTY WORK

Lightweight aluminum and stainless steel are used for heavy-duty work by welding STEELMESH to the sheets for reinforcement. An example is the successful application of flat rolled steel reinforced with STEELMESH for the fuselage, wings, tail surfaces and cowlings of airplanes. In a given area of STEELMESH, only 10% is solid steel (the remainder is interstices). It is, therefore, possible to spot weld this mesh to a thin sheet and secure a composite construction much stronger than a solid steel sheet of the same weight.

The strength imparted by STEELMESH is due to the trusslike formation of the mesh and to the fact that in the manufacture of this product, the openings are simultaneously slit and cold drawn or expanded.

STEELMESH is used in the construction of bulkheads, open partitions, insulation support, guards and ventilators, lockers, cages, truck bodies, shelving, racks, baskets, drying trays, gratings, air filters, drainers, storage bins, grille work, screening, mastic flooring, dehydrators, toys, novelty work and for many other purposes.

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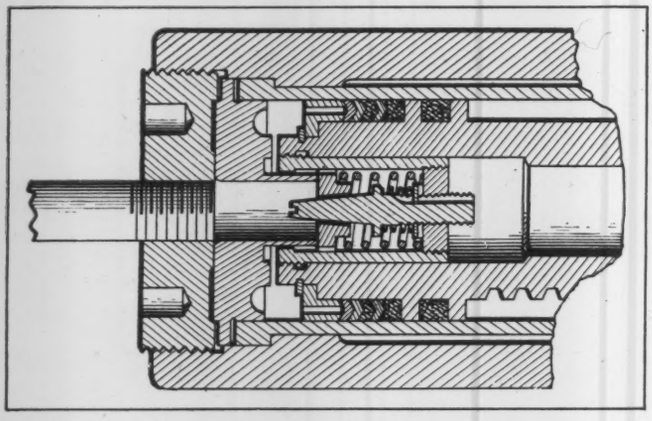
Noteworthy Patents

CUSHIONING TO OBVIATE SHOCK or jolt often encountered at the extreme limits of the stroke of hydraulic pistons is provided by the design covered in patent 2,412,-975. Assigned to the Parker Appliance Co. by R. E. Dunnebeck, the cushioning device is said to be especially effective with systems employing low-viscosity hydraulic

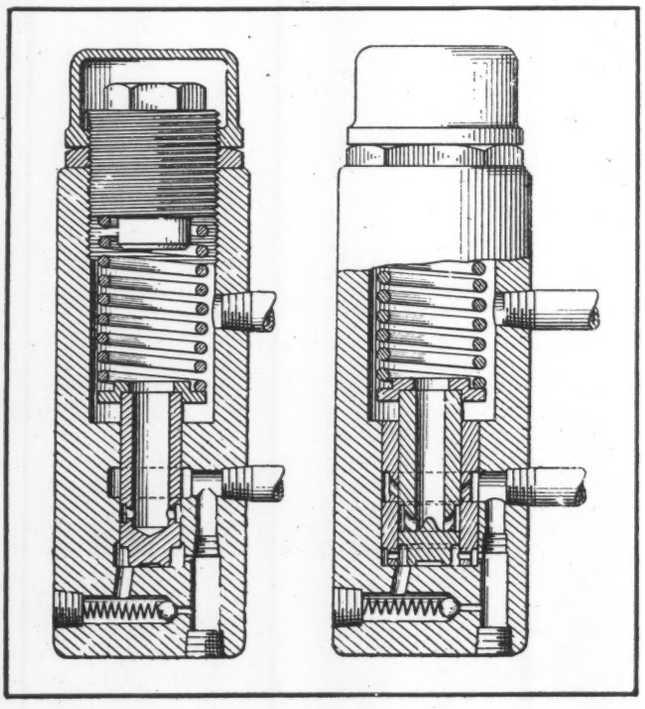


fluid. Fully adjustable, the mechanism may be used at either end of the piston and cylinder and is installed as a unit. A sleeve on the cylinder head contacts a spring-loaded, taper-bore sliding member on the piston which, as the piston nears the end of its stroke, retracts over a similarly tapered stud to restrict fluid flow and thereby bring the piston to a gradual stop.

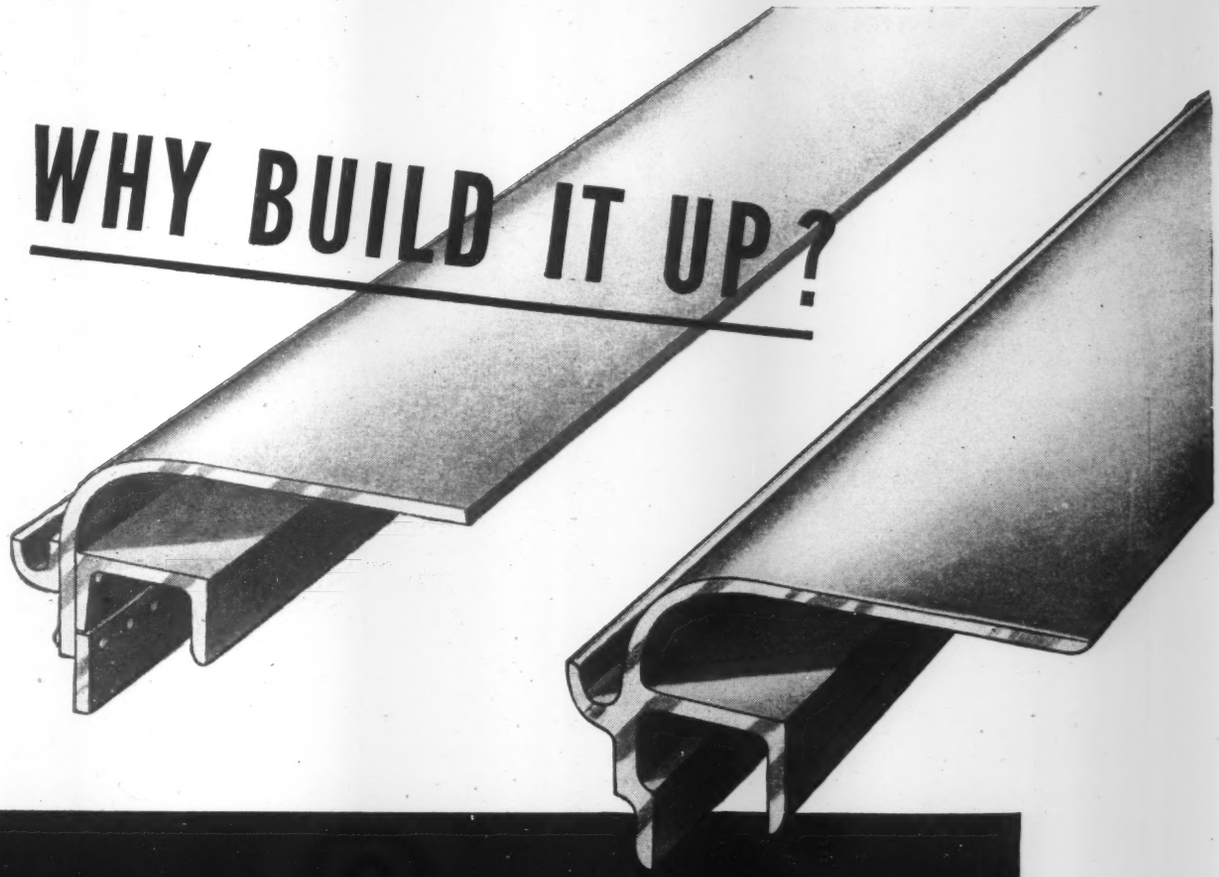
SELF-LUBRICATION is accomplished with the gyro design covered in patent 2,413,285 assigned to Jack & Heintz Precision Industries Inc. by Samuel Bousky. The gyro wheel and gimbal suspension frame is entirely enclosed in a hermetically sealed and evacuated chamber to eliminate power losses due to windage. Rotation of the gyro creates in effect a continuous gaseous lubricant vapor from the enclosed oil which bathes the bearings. Axis of the gyro is hollow, passages outward through the rotor creating a centrifugal action to circulate the oil mist continuously.

MEASUREMENT of tension or compression strains while simultaneously controlling loading in accordance with either is possible with a carbon pile electrical resistance unit described in patent 2,411,139. This strain-measuring gage is so designed that it can be incorporated in and be made a part of the structural member on which the stress is to be measured. By assembling the carbon pile units under precompression, both compression and tension strains are always transmitted to the strain-sensitive element as relative or differential compression effects. The patent is assigned to the Budd Co. by N. H. Roy and J. L. Bisesi.

PRESSURES REQUIRED to initiate or terminate fluid flow with the hydraulic relief valve discussed in patent 2,411,930, unlike conventional units, are substantially equal. Desired maximum working pressure of a hydraulic system is maintained by the valve within extremely narrow limits. As pressure develops the valve plunger moves to open the valve and relieve the excess. Flow of fluid to relief, however, acts to supplement the return spring of the valve and create a closing pressure approximately equal to that required for opening. The patent has been assigned to Ex-Cell-O Corp. by Max A. Mathys.



WHY BUILD IT UP?



Buy an Extruded Shape, READY-TO-USE

You save material and labor when you order an aluminum extruded shape that fits your design. No need to build it up from angles, channels, tees, and other conventional shapes.

The aluminum in an extruded shape is used at maximum efficiency . . . strength where strength is needed, economy of metal where loads are light. No lap joints and double thicknesses to rivet through, no extra rivets to add weight.

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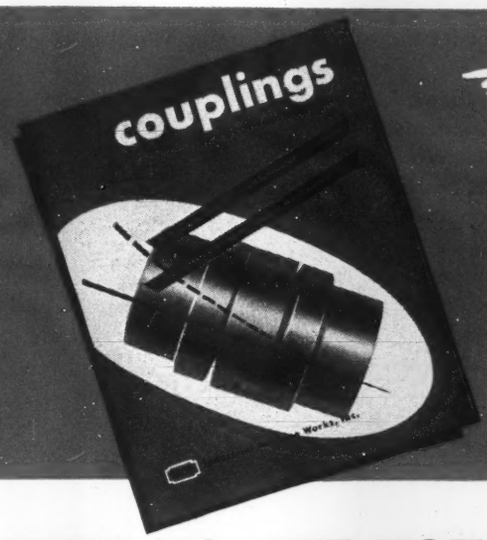
PAUL H. MAURER, recently appointed chief engineer in charge of production engineering, research and development of The National Pneumatic Co., joined the company in January, 1945 as research engineer, his post prior to the new appointment. After completing his education, Mr. Maurer was employed by Eclipse Aviation Division of Bendix Aviation as an engineer on aircraft electrical equipment, later being transferred to the Machine Division as development engineer on automotive electrical devices. He then became connected with the B. K. Division as development engineer on automatic transmissions. Leaving Bendix, he joined Hudson Motor Car Co. as electrical engineer in charge of automatic transmissions, electrical equipment and car radios. At the outbreak of war, he was loaned to Sparks-Withington Co. as chief engineer. A year later he returned to Hudson which then was operating a Naval Ordnance plant. From there he was sent to General Electric Co. as Hudson representative on a hydraulic gunfire control project. Resigning from Hudson he became executive engineer for Redmont Co., remaining until he joined The National Pneumatic Co.

MAX M. ROENSCH, in his new position as a member of the engineering department of the research laboratories of Ethyl Corp., will, as one of the three co-ordinators on the staff of the director of engineering research, be responsible for research and developing pertaining to the power, economy and durability of engines. After graduating from the University of Michigan, Mr. Roensch became associated with, and later head of, the powerplant laboratories of Chrysler. While there he had an active part for many years in the development of engines. Later in becoming a member of the staff of the chief engineer in charge of the laboratories, his endeavors were still primarily along the same lines. He was closely associated with the development of the Multibank tank engine built by Chrysler at the request of the Ordnance Department to alleviate a serious shortage of engines for tank use during the early phases of the late war. Mr. Roensch left Chrysler to become chief engineer of Cleveland Bronze Co., where he remained prior to joining Ethyl Corp.

R. MANGOLD, new chief engineer at Diesel Power Inc., has had considerable experience in automotive, machine tool and diesel engineering. Graduating with honors in mechanical engineering from Technische Hochschule, Stuttgart, Germany, he spent one and one-half years as laboratory engineer and laboratory chief engineer with Robert Bosch A. G., developing electrical accessories. For the next year and a half, he was production and maintenance engineer on large machine tools, shears, punch presses, etc., for Maschinenfabrik, Weingarten, Germany. Coming to the United States in 1926, he became department head in engineering divisions of Robert Bosch Magneto Co., Long Island City, N. Y., and later with the United Bosch Corp. Again he was responsible for the design of various electrical automotive accessories, generators, starting motors, etc. Later, as chief design engineer and chief draftsman for Guiberson Diesel Engine Co., he worked on radial diesel engines, including research and test equipment for them. He remained with this company from 1941 to 1945,



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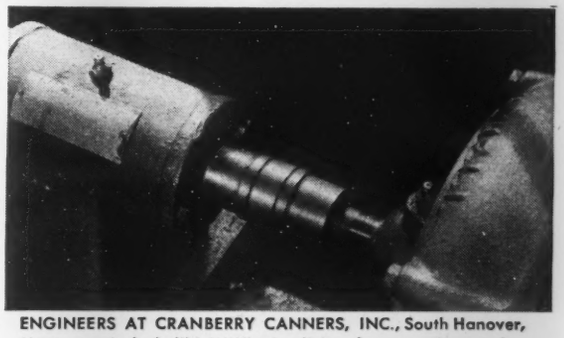
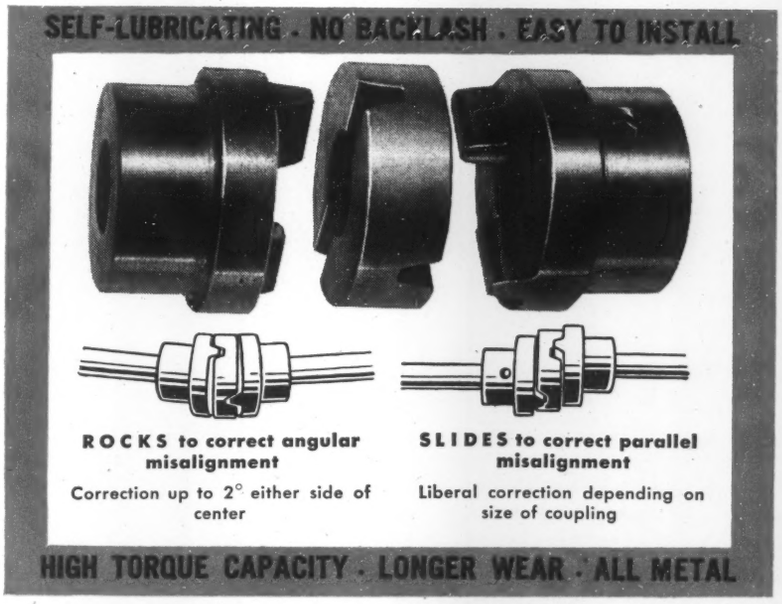


ENGINEERS AT CRANBERRY CANNERS, INC., South Hanover, Mass., particularly like IMW's simplicity of construction—makes inspection quick—assembly easy.



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and during this period also acted as instructor for testing of internal combustion engines at the Southern Methodist University. From 1945 to the time of his present appointment, he worked as mechanical engineer with Shaffer Tool Works, designing and developing small aviation diesel engines, as well as doing research and designing test equipment.

♦

HAROLD D. KOEKSTRA is the new chief engineer of the Aircraft & Components Service, Civil Aeronautics Administration. These duties will prevent his continuing as CAA's representative on the SAE Aircraft Materials and Processes Committee. This has been assigned to BURDELL L. SPRINGER, chief of the CAA Materials and Processes Section.

♦

WALTER D. APPEL, formerly product development engineer with General Motors Overseas Operations, New York, has joined Willys-Overland Motors Inc. as assistant to the vice president of engineering in charge of product development.

♦

JOHN C. MONAHAN, who had been connected with Gar Wood Industries Inc., as chief hydraulic engineer, has recently formed the Hydraulic Accessories Co., Detroit, with which he is serving as chief engineer and sales manager.

♦

DR. SIDNEY M. CADWELL, previously assistant general manager of the United States Rubber Company's tire division, has been appointed director of research and technical development. He brings to his new position twenty-seven years of administrative and scientific experience in the fields of rubber and plastics.

♦

MICHAEL A. PARADISO has recently become design engineer with Douglas Aircraft Co. Inc., Santa Monica, Calif. He had been connected with the Sikorsky Aircraft division of United Aircraft Corp., Bridgeport, Conn., as assistant group engineer.

♦

LELAND MELVIN has resigned as chief design engineer with the Romec Pump Co., Elyria, O., to become affiliated in a similar capacity with A. W. Hecker Co., Pump Division, Cleveland.

♦

W. W. CARY JR. is the new machine load analyst with International Harvester Co., Chicago. He had been section head of Wright Aeronautical Corp., Lockland, O.

♦

CHARLES S. STONE has recently become development engineer with Airesearch Mfg. Co., Inglewood, Calif.

♦

H. G. ERICKSON, formerly preliminary design engineer with Beech Aircraft Corp., Wichita, Kans., has joined Luscombe Airplane Corp. of Garland, Tex., as structural design engineer.

♦

WILLIAM F. WRIGHT has joined Boeing Airplane Co., Wichita Division, as head engineer in the project design group.

♦

V. M. DOBEUS has resigned as chief engineer, Allis-Chalmers Mfg. Co., Springfield, Ill., to take the position of president of the newly established Tractomotive Corp., Findlay, O., which will manufacture earth-moving equipment for industrial crawler and wheel tractors.

♦

GEORGE L. BEST has risen through various engineering assignments to his present appointment as vice president of the Western Electric Co. Previous to this new appointment he had been assistant vice president of the American Telephone and Telegraph Co.

♦

WILLIAM C. HOUSE recently has been elected vice president in charge of engineering and manufacturing of Lyon-Raymond Corp. He has been with the organization for twenty years.

♦

MAURICE J. HOKE as chief engineer of the Crankshaft and Camshaft Divisions of the Ohio Crankshaft Co., will be in charge of all processing and development work in these divisions.

♦

E. J. SCHWANHAUSSER, vice president of Worthington Pump & Machinery Corp., has been re-elected president of the Diesel Engine Manufacturers Association.

♦

ROBERT L. CRINNIAN has been named assistant chief engineer of Pioneer Engineering & Mfg. Co. Mr. Crinnian, a well known industrial engineer, is a founder and past president of the American Society of Industrial Engineers.

♦

DR. J. B. AUSTIN, assistant director of the Research Laboratory of United States Steel Corp. of Delaware, will succeed Dr. Johnston who is retiring as director.

♦

EUGENE SONOFF as technical service engineer of the American Standards Association will collect and supply technical information concerning American standards and those of other countries. He will conduct world-wide surveys of standards available in any particular field for use by committees of ASA.

♦

SYDNEY W. LOHMAN, formerly associated with Lester-Phoenix Inc., has joined Clinford Corp. as chief engineer.

♦

WILLIAM C. OBEREM has resigned as chief engineer of Snyder Tool & Engrg. Co. to become connected with Farrel-Birmingham Inc., Buffalo Division, in an engineering development capacity.

♦

JOHN B. CALDWELL, identified with the development of pumps and various types of hydraulic equipment, has been appointed chief engineer of the Blackmer Pump Co., L. R. DEWOLF and V. A. BRUNSON have been appointed senior engineers.

♦

WILLIAM S. DUNCAN has joined the V. & E. Mfg. Co. of Pasadena, Calif., in an engineering capacity. Mr. Duncan was formerly chief engineer of the W. M. Welch Mfg. Co., and for many years was with Bell & Howell Co.

♦

DR. LAURENCE C. HICKS, associated with Allegheny Ludlum Steel Corp., since 1933, has become assistant director of research. He started in the research laboratory and at the time of his promotion was associate director of research in charge of magnetic steel and allied products.

The new induction heating method of producing heat treated quenched and tempered cold finished steel makes possible an unusually accurate control of the process. Bars are fed individually through the coil and heated to exactly the desired temperature. They pass immediately through a cone of water sprays which is used to closely regulate the cooling. The Electreat cold finished bars produced by J&L with this process have a degree of uniformity not possible with conventional methods. Write for complete information.

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Milford SEMI-TUBULAR Rivets -- **SOLID** where solidity is required for strength. **SEMI-TUBULAR** to save time in setting.

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BUSINESS AND SALES BRIEFS

OPENING of a new sales office at 1500 Walnut St., Philadelphia, has been announced by the American Brake Shoe Co., New York. It will be occupied jointly by representatives of four divisions of the company. James J. Nelson will represent the National Bearing Division; Thomas N. Mitchell, district manager, the Kellogg Division; L. John Hardwood, the Electro-Alloys Division; and George E. Anne, the Brake Shoe & Castings Division.

♦

H. K. Porter Co. Inc., Pittsburgh, has named **Clarence R.** Abitz as general manager of the McKees Rocks Works of the American-Fort Pitt Spring Division.

♦

Expansion of its plant facilities is planned by SKF Industries Inc. to meet increased postwar demands for spherical roller bearings. As part of the expansion, the cast-iron department (which produces antifriction bearing pillow blocks) will be moved gradually to Hornell, N. Y., and the cage-stamping department to Shippensburg, Pa. Occupancy of these plants is expected to begin about July 1.

♦

Previously sales manager, Gordon J. Wygan has been appointed assistant sales manager of Titeflex Inc., Newark, N. J. He will assist in directing the sales and servicing of all Titeflex products.

♦

Discontinuance of all escalator clauses in acceptance of orders for springs, wire forms and light stampings has been announced by Reliable Spring & Wire Forms Co., Cleveland 9. The company also states it has refrained from any general price raise on its line despite recent higher material costs.

♦

Two new sales representatives have been appointed by Bright Light Reflector Co. Inc., Bridgeport, Conn., manufacturer of Silv-A-King fluorescent and incandescent lighting equipment. They are: Harry A. Miller, Dallas, Tex., to cover the states of Arkansas, Oklahoma and Texas; and Donald S. Gleason, Seattle, to handle the territory embracing Idaho, Oregon and Washington.

♦

Recently G. M. Forslund joined the organization of Rodpak Mfg. Co., San Francisco 3, and will serve in the capacity of vice president and sales manager. The company produces a line of metallic packings.

♦

With offices at 4030 Chouteau Ave., St. Louis, George F. Heath has been named district sales representative for Cleveland Worm & Gear Co. and Farval Corp., Cleveland.

♦

Formation of Hydro-Line Mfg. Co., 711 Nineteenth St., Rockford, Ill., has been announced recently. The new company will manufacture a complete standard line of both air and hydraulic cylinders as well as special cylinders of both types, and will engage in the design and manufacture of special machinery and equipment. G. A. Markuson is president and Gust

IT TAKES MORE THAN MUSCLE

According to legend, Polydamas, the Greek athlete, killed a lion with his bare hands, stopped a chariot in full flight, and lifted a raging bull off the ground with ease. His career, however, came to a spectacular end when he tried to catch a huge falling rock.

Today, sudden, heavy loads end the life of many steel parts. Low temperatures, for instance, can have a depressing effect on the impact strength of steels. Molybdenum steels, which combine deep hardening and freedom from temper brittleness, reduce this risk.

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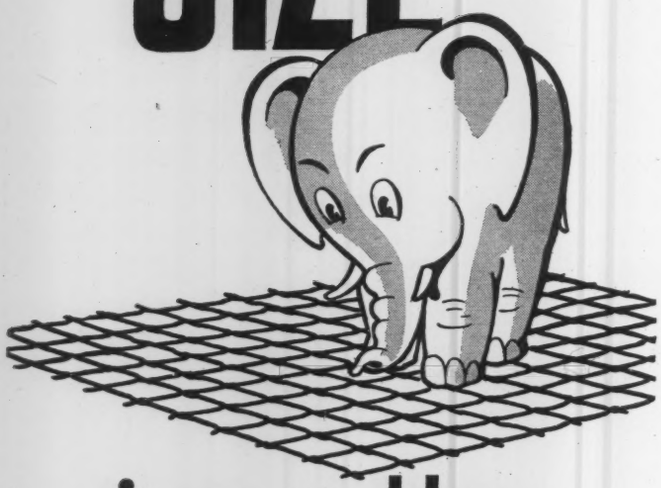

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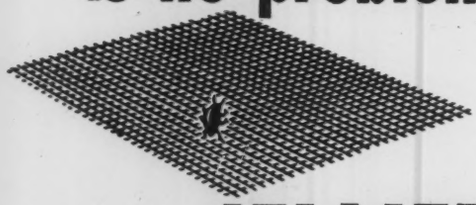

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For quality wire mesh — contact Jelliff — makers of wire mesh products for over sixty years. Commercial sizes available in standard lengths of 100 feet and widths of 24 to 72 inches. Meshes of specified gauge and weave made and cut to order. Available crimped, calendered and rolled. Jelliff engineers keep abreast of current developments in new alloys, coatings and processes and apply them when studying your requirements. For best results and maximum economies, look to Jelliff.

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LEKTROMESH
RESISTANCE WIRE

WIRE MESH PARTS
WIRE CLOTH
STRAINERS • FILTERS

SOUTHPORT — CONNECTICUT

WIRE PRODUCTS SINCE 1860

J. Peterson is vice president. Both men were associated formerly with John S. Barnes Corp., Rockford, Ill.

♦

Askania Regulator Co. has moved to new and larger quarters at 240 East Ontario St., Chicago 11. General offices, factory and both hydraulic and electronic development laboratories now are located in the same building.

♦

Previously in charge of the Truarc technical service staff, Harold F. Bower has been made sales manager of the Truarc Retaining Rings Division, Waldes Kohinoor Inc., Long Island City, N. Y. Under his direction the facilities of the Truarc sales department will be enlarged to permit a more integrated selling and technical program.

♦

Henceforth Hannifin Mfg. Co. will be known as Hannifin Corp. Also, with the completion of a new office addition to the main Chicago plant, the general offices have been moved from 621 South Kolmar Ave. to 1101 South Kilbourne Ave. The company also announced the election of Ellwood G. Peterson, formerly vice president and general manager, as president; and the re-election of Harry H. Adams, Otto J. Maha and Clarence B. Mitchell as vice presidents.

♦

Breeze Corps Inc., Newark, N. J., has acquired all the capital stock of Aircraft Standard Parts Co. Inc., Rockford, Ill., patentee and manufacturer of the Aero-Seal clamp. Philip M. Stephenson will continue as president of the newly acquired company, and Howard F. Hansell Jr. as eastern sales representative.

♦

Connected with the steel industry since 1932, C. E. Jones has been named vice president of Agaloy Tubing Co., Springfield, O.

♦

Appointment of John O. Tragard as eastern regional sales manager has been announced by The Fulton Sylphon Co., Knoxville, Tenn., producer of temperature controls, bellows and bellows assemblies. Mr. Tragard will supervise territory north of Richmond, Va., and from the Atlantic seaboard west to Buffalo. His headquarters are in the Reynolds Metals Bldg. at 19 East 47th St., New York.

♦

Formerly sales manager for Penn Carbide & Alloy Casting Co., C. R. Harmon has been named Pittsburgh district sales manager for Firth Sterling Steel & Carbide Corp., McKeesport, Pa.

♦

Change of name to Engineering Controls Inc. has been announced by Pacific Enterprise Products Co., a firm of manufacturing, designing and consulting engineers with main offices at 2833 East 11th St., Los Angeles 23. Lloyd C. Harbert, formerly vice president and general manager, is now president.

♦

Associated with the company for several years as a representative and tool engineer, Lawrence W. Guild has been appointed manager of the New England district of Kennametal Inc., Latrobe, Pa. This new district comprises territories covered by the Hartford, Springfield and Boston offices. Mr. Guild will make his headquarters at the Springfield, Mass., office at 1537 Main St.

♦

George F. Jenkins has been promoted to assistant sales manager of The National Screw & Mfg. Co., Cleveland. For the past two years he served as district sales manager in Chicago, covering the midwestern territory. In his new position he succeeds

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. . . for authoritative answers to today's Aluminum problems

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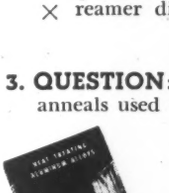
1. QUESTION: What are the two most critical factors in the welding of aluminum?

"Welding Aluminum"—Gives detailed information on the 11 aluminum welding processes from edge preparation to finishing. Fully illustrated with photographs, chart and tables.

ANSWER: Oxidation and apparent weakness of aluminum at high temperatures.

2. QUESTION: When drilling a hole to be machine-reamed in aluminum alloys, how do you figure the proper allowance?



"Machining Aluminum Alloys"—124 pages packed with practical up-to-date facts. Eight double-page charts of easily usable data on tooling, speeds, and feeds, for eight important types of machining operations.

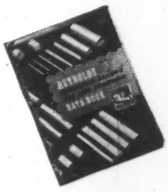
ANSWER: The formula is Drill diameter=0.95 × reamer diameter.

3. QUESTION: What are the three main types of anneals used with aluminum alloys?

"Heat Treating Aluminum Alloys"—The "What, Why, and How" of the metalling and heat treatment of different aluminum alloys and tempers. Complete with tables, photographs and charts.

ANSWER: Horizontal bulk anneal, vertical anneal, flash anneal.

4. QUESTION: How many Reynolds alloys are produced in forging stock?



"Aluminum Alloys and Mill Products Data Book"—Contains 248 pages, 106 tables, 20 photographs . . . of specific facts about aluminum alloys and aluminum mill products. Complete information on ordering to your needs.

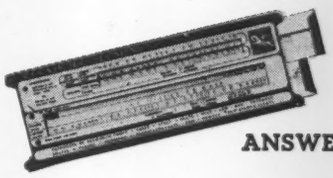
ANSWER: Eight—14S, 17S, 18S, 25S, 32S, A51S, R317, R353.

5. QUESTION: How quickly can I find out about the properties of aluminum alloys?

"Alloy Selector"—Just two simple settings give you mechanical properties, chemical composition, physical constants, thermal treatments, and specification number of 18 aluminum alloys.

ANSWER: In 1 minute with Reynolds Alloy Selector.

6. QUESTION: How can I save time in calculating weights?



"Metals Weight Calculator"—Simple . . . accurate . . . fast. Calculates the weights of aluminum, magnesium, steel, brass, copper and nickel in various forms (sheet, rod, etc.). Range—from .0006 lbs. to 3,000 lbs.

ANSWER: Use the Reynolds Weight Calculator.

Reynolds Metals Company 1747-A1-3B
2521 South Third Street, Louisville 1, Kentucky

Please send me:

( ) The complete Reynolds Library on Aluminum — $6.50
( ) "Welding Aluminum" — $1.00
( ) "Machining Aluminum Alloys" — $1.00
( ) "Heat Treating Aluminum Alloys" — $1.00
( ) A Reynolds Data Book—$2.00
( ) A Reynolds Alloy Selector—$1.00
( ) A Reynolds Weight Calculator—$.50

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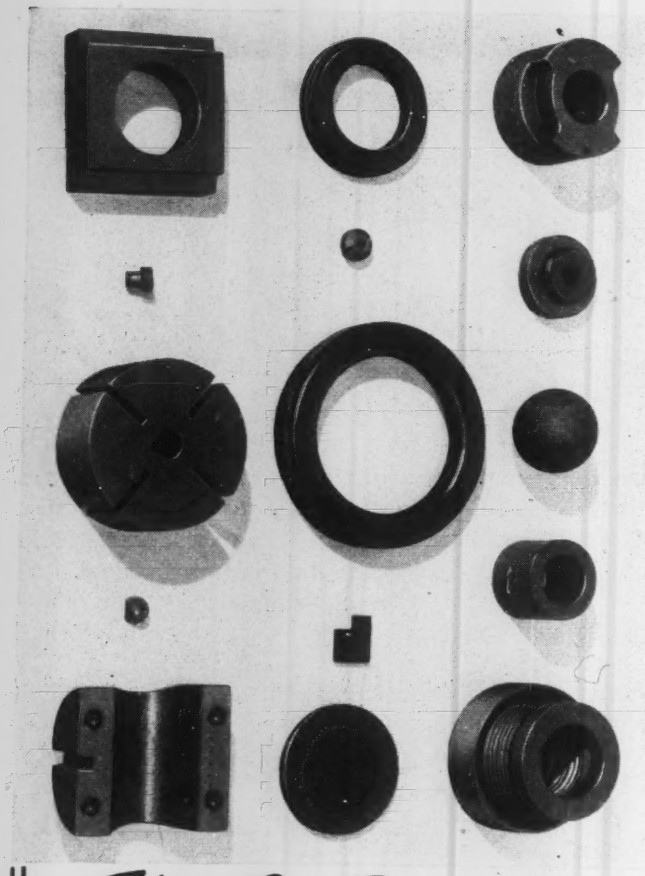

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● Proven by wide use under severe conditions, Supergraph graphite-carbon parts are non-corrosive, non-warping, self-lubricating, chemically inert. In Supergraph Seal Rings you get perfect sealing, ability to withstand high pressures, long care-free service. With adequate data to work from, we will be glad to recommend the right Supergraph part for your requirements . . . Write us now.

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"Since 1919" **SUPERIOR CARBON** *Parts*

C. L. Kerr who resigned to form his own company, C. L. Kerr Industries Inc., 7910 Carnegie Ave., Cleveland. The new company will make screw machine products, specializing in short run quantities and handling sizes of from 3/6 to 2 1/4 inches in diameter.

MEETINGS AND EXPOSITIONS

May 15-17—
Society for Experimental Stress Analysis. Annual meeting including a symposium on shock and impact to be held at Stevens Hotel, Chicago. Additional information may be obtained from the society at P. O. Box 168, Cambridge 39, Mass. W. M. Murray is secretary-treasurer.

May 20-21—
International Acetylene Association. Annual convention to be held at Cincinnati, O. Additional information may be obtained from headquarters of the society at 30 East 42nd St., New York 17.

May 21-24—
American Society of Mechanical Engineers. Oil and gas power nineteenth national conference to be held at Cleveland. Additional information may be obtained from headquarters of the society at 29 West 39th St., New York. C. E. Davies is secretary.

May 22-31—
Mid-America Exposition to be held at Public Auditorium, Cleveland. Parker Hill, vice president of the Cleveland Chamber of Commerce, is secretary.

May 26-29—
American Society of Mechanical Engineers. Aviation division meeting to be held at Los Angeles. Additional information may be obtained from headquarters of the society at 29 West 39th St., New York. C. E. Davies is secretary.

June 1-6—
Society of Automotive Engineers Inc. Summer semiannual meeting to be held at French Lick Springs Hotel, French Lick, Ind. John A. C. Warner, 29 West 39th St., New York 18, is secretary and general manager.

June 2-4—
American Gear Manufacturers Association. Thirty-first annual meeting to be held at The Homestead, Hot Springs, Va. Newbold C. Goin, Empire Bldg., Pittsburgh 22, is executive secretary.

June 2-4—
American Society of Heating and Ventilating Engineers. Semiannual meeting to be held at Hotel del Coronado, Coronado, Calif. A. V. Hutchinson, 51 Madison Ave., New York 10, is secretary.

June 12-13—
American Society of Mechanical Engineers. Wood industries division meeting to be held at Madison, Wis. Additionl information may be obtained from headquarters of the society at 29 West 39th St., New York. C. E. Davies is secretary.

June 16-19—
American Society of Mechanical Engineers. Semiannual meeting to be held at Stevens Hotel, Chicago. C. E. Davies, 29 West 39th St., New York, is secretary.

June 16-20—
American Society for Testing Materials. Fiftieth annual meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. R. J. Painter, 1916 Race St., Philadelphia 3, is assistant to the secretary.

June 18-21—
American Society for Engineering Education. Annual meeting to be held at Nicollet Hotel, Minneapolis. F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa., is secretary.

June 23-25—
American Society of Mechanical Engineers. Applied mechanics division meeting to be held at Schenectady, N. Y. Additional information may be obtained from headquarters of the society at 29 West 39th St., New York. C. E. Davies is secretary.

June 23-27—
American Electroplaters' Society. National convention to be held in conjunction with Industrial Finishing Exposition. Convention headquarters will be at Hotel Statler, Detroit, and exposition will be at Convention Hall. Additional information may be obtained from headquarters of the society at 93 Oak Grove Ave., Springfield, Mass.

IF YOU MAKE ENGINE-DRIVEN PRODUCTS THIS INFORMATION MAY HELP YOU SELL 100% MORE!

Would reduction of 25 pounds weight help your equipment?

You can cut *at least* 25 pounds from the weight of your product using modern McCulloch die-cast engines. How much do your present engines weigh? Compare their weights with the McCulloch engines shown on this page.

If you can reduce the weight of your product by substituting a modern light-weight McCulloch engine, you increase your sales potential in nine cases out of ten. Especially so if you're manufacturing items such as scooters, lawn mowers, farm implements, portable generator sets, or any equipment that requires handling by users . . . . In addition, *your freight costs go down.*

Would a specially built engine improve appearance or operation?

Many products—possibly yours—get added sales appeal through use of engines specially designed for specific products. Higher efficiency and lower manufacturing cost can often be obtained by use of a more direct drive.

We are genuinely interested in development of special engines for quantity production with various types of mounting surfaces; built-in gear or pulley housings; vertical or horizontal drives; or other special arrangements to make your engines fit your product like a glove. We have our own research laboratories, die-making departments and die-casting machines for this work.

McCulloch Motors New Plant was designed especially for the efficient mass-production of 2-and 4-cycle engines, and is already in volume production.

INFORMATION COSTS NOTHING . . .

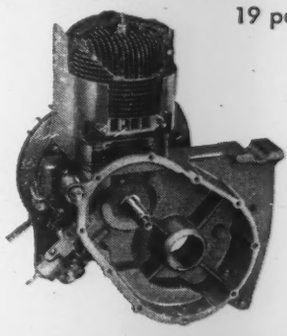
Send for an illustrated brochure on McCulloch engines, complete with facts, figures, and drawings.

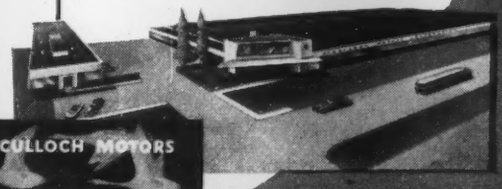
VERTICAL DRIVES-MODEL 1200D

Now in volume production...weighs 24 pounds, develops 2.5 hp at 2500 rpm rated speed. Anti-friction bearings throughout. Air-cooled, 2-cycle design.

SPECIAL DESIGNS-MODEL 1200B

Illustrates special McCulloch design for a chain-saw application. Four hp at 4000 rpm rated speed. Air-cooled, 2-cycle design. Basic engine weighs 19 pounds.





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Precision manufacture . . . the finest materials . . . a wide selection of stock sizes and styles . . . these are a few of the features which have earned a fine reputation for "Blue Devil" socket screw products.

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NEW MACHINES

And the Companies Behind Them

Excavating

Tamper having average pressure on each foot as follows: Empty drums, 2350 lb; water-filled, 4000 lb; wet sand-filled, 5660 lb. William Bros. Boiler & Mfg. Co., Minneapolis.

Portable self-priming pumps. Priming action without priming valves or "recirculation". 1½ to 4 in. pumps available with standard air-cooled gasoline engines, while 6 to 8 in. units are equipped with water-cooled engines, either gasoline or diesel. Worthington Pump & Machinery Corp., Harrison, N. J.

Dual-purpose bulldozer shovel equipped with either a full track width, one-yard bucket or bulldozer plate. Frank G. Hough Co., Libertyville, Ill.

Truck crane. Has lifting capacity of 40,000 lb with outriggers and 15,000 lb without them. Crane can go wherever trucks travel. Has hinged boom which folds away. Koehring Co., Milwaukee.

Force-feed loader with finger-tip hydraulic control. Has four levers for raising and lowering feeder, mold-board, throat, and conveyor. Athey Products Corp., Chicago.

2-ton hydro-crane with full hydraulic control of all operation. Tubular boom raises, lowers and telescopes from 16 to 22 feet. Has 360 deg. swing. Milwaukee Hydraulic Corp., Milwaukee.

Finishing

Alloy sprayer. All electric, using ac or dc current. Air requirements are 3½ cfm at 30 to 40 lb pressure. Temperature control adjustable from 100 to 600 F and maintained within 1/10 degree. K. & F. Metal Spray Industries, Detroit.

Heat Treating

Electric furnace with stepless heat control between 500 and 1850 F. Available for direct and alternating current of any cycle. Inside dimensions are: 4 x 3¾ x 3¾ in. Thermo Electric Mfg. Co., Dubuque, Ia.

Industrial

Air-cooled portable compressors in five models of 60, 105, 160, 210 and 315 cfm capacity. Of V-type cylinder design except Type 315 which is of W-construction. The Davey Compressor Co., Kent, O.

High-pressure system fan heater. Dual-coil system eliminates complex secondary piping, reducing stations and accessories. Niagara Blower Co., New York 17.

Pneumatic-powered hand tool for solderless wire terminals. Made for wire sizes from 22 to 14. Toggle action employed provides 2000 lb crimping pressure from 85 psi air pressure. Aircraft-Marine Products Inc., Harrisburg, Pa.

Power-operated bench model positioner for work weighing 100 lb or less. Work may be tilted to 135 deg or revolved 360 deg., locking in any position. Industrial Division, Ransome Machinery Co., Dunellen, N. J.

Materials Handling

Special pallet truck for reels or similar bulky cylindrical items. Forks are widened to straddle reel when lowered, and to lift from floor when raised. Can handle reels of 54-in. diam and 38-in. wide. Automatic Transportation Co., Chicago 20.

Truck, powered by small 6-hp gasoline engine developing 2650 rpm. Capacity is 4000 lb on any standard skid up to 8 mph. Northrop Aircraft Inc., Hawthorne, Calif.

Metal Working

Plain grinding machines with improved enclosure of electrical controls. Headstock, table, grinding wheel and coolant pump driven by separate motors. One main pushbutton switch governs starting and stopping. Brown & Sharpe Mfg. Co., Providence 1, R. I.

Surface grinding machine available with either a 1 1/3 hp motor in base or 1 hp motor driving spindle direct. Grinds work to 18 x 6 x 9½ in. using a 7-in. diam wheel. Brown & Sharpe Mfg. Co., Providence 1, R. I.

Gear-shaving machine for high production operations. Has two cutting stations and four work stations. Incorporates crossed-axes shaving principle. National Broach & Machine Co., Detroit.

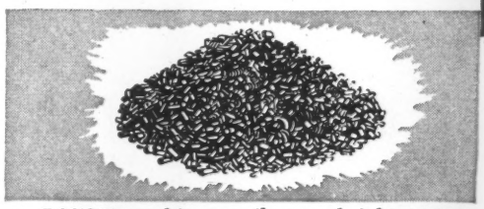
POUND FOR POUND...

...get 3 times as many finished parts!

HIGHER SPEEDS

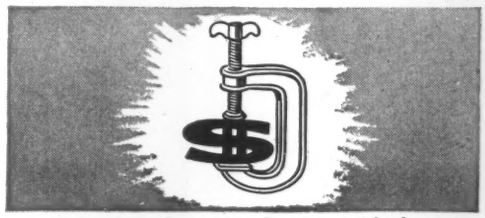
R317-T can be run at high-profit speeds, comparable or in some cases, higher speeds than brass.

CLOSER TOLERANCES



R317-T machines easily to a bright, natural finish. Forms small chips. Does not run with the tool. May be worked to very close limits.

LOWER-COST MACHINING



Accurate volume production with fewer rejects. Result: lower cost, more profit per finished part.

Yes—thanks to the favorable weight factor aluminum gives you three times as many finished parts per pound as brass.

By the foot you pay less for aluminum than you do for brass. All of which adds up to a saving of about 50% in material cost.

For high speeds, excellent machinability, a bright, natural machine finish and LOWER COSTS, use R317-T, Reynolds new aluminum screw machine stock. Only a fraction of the cost per finished piece as R317-T weighs only ⅓ as much as brass (and other heavy non-ferrous metals).

Order now. R317-T is ready for immediate shipment from Louisville warehouse stock in rounds and hexagons in all standard sizes. 17S-T, Reynolds standard screw machine stock, is also available now.

Consult Reynolds. Reynolds is ready to work with your engineers. Offices in principal cities. Phone nearest office . . . or write Reynolds Metals Company, Aluminum Division, 2521 South Third Street, Louisville 1, Kentucky. See Sweet's or write for Catalog 100-B "Reynolds Aluminum—Available now for Today's Products."

REYNOLDS METALS

REYNOLDS ALUMINUM

NOW...

2 MORE ALLSPEED SELECTORS JOIN THE WORTHINGTON VARIABLE SPEED DRIVE FAMILY

MODEL E: 2.8 to 7½ hp; ratio 6 to 1; speed range 400/2400 (with 1725 RPM Input)

MODEL D: 2 to 5 hp; ratio 8 to 1; speed range 360/2880 (with 1725 RPM Input)

MODEL C: 1 to 3 hp; ratio 9 to 1; speed range 400/3600 (with 1725 RPM Input)

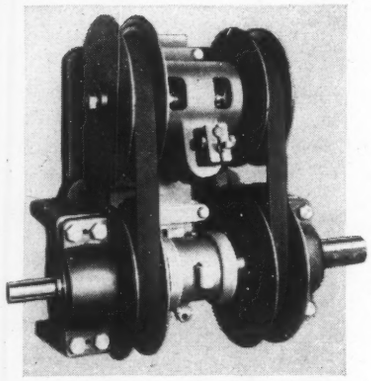
MODEL A: ¼ to ¾ hp; ratio 16 to 1; speed range 215/3450 (with 1725 RPM Input)

Now . . . it's easy to get peak production speeds at higher horsepowers, too!

Yes, you can now apply the many advantages of Worthington Allspeed Selectors to your heavier machines. The new D and E models have the same unique time-, space-, and money-saving features that in the past 4 years have made the lighter A and C models nation-wide favorites on applications requiring peak production speeds with precision control.

How to select the right size

To be sure of getting the right selector for the job, call in your nearby Worthington Distributor. He can select the one right unit for you in a matter of minutes. Ask him for a copy of the Worthington Allspeed Selector Bulletin . . . which proves that in variable speed drives, too, *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Merchandising Division, Harrison, New Jersey. 36 District Offices throughout the U.S.*



Only Worthington Allspeed Selectors Offer All These Advantages

Belts in tandem permit operational smoothness not possible in single-belt drives . . . exclusive, automatic, positive belt-tensioning . . . high speed ratios in the smallest space . . . belts quickly changed without dismantling unit.

B7-3

WORTHINGTON

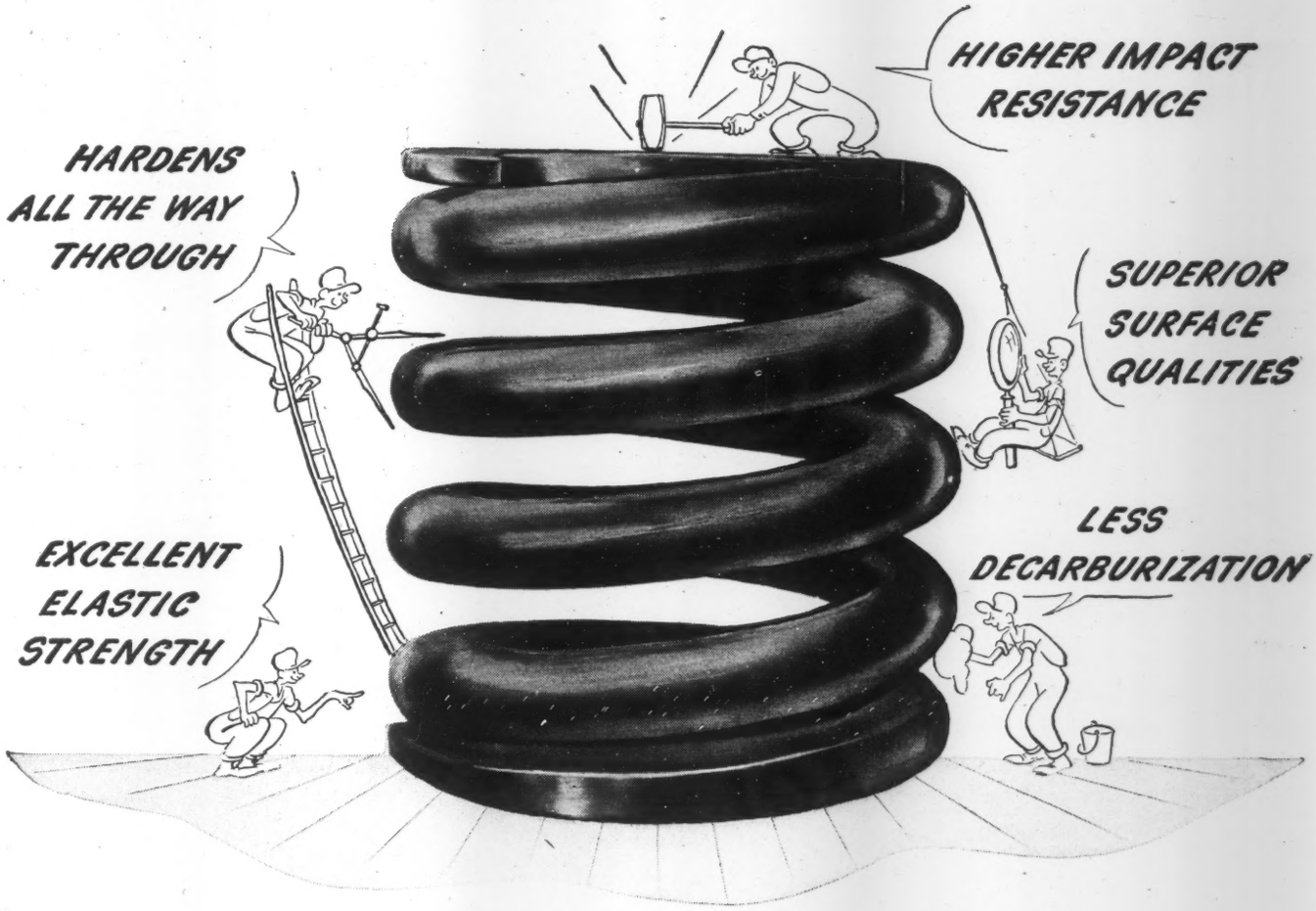
PRODUCTS BASED ON MARKET RESEARCH

Centrifugal Pumps · Rotary Pumps · Steam and Power Pumps · Vertical and Horizontal Compressors · Multi-V-Drives · Variable Speed Drives

Hot Coiled Springs Last Longer

when made of

Type "8655" Nickel Alloy Steel



Here's a steel that offers remarkable advantages for all types of heavy-duty springs . . . great shock resistance at normal and sub-zero temperatures, high elastic properties that resist permanent set, good hardenability . . . to mention a few.

It will pay you to investigate Type "8655" Nickel alloy steel for springs used in railway car suspensions, draft gears, snubbers . . . for tractors, rolling mills, heavy forging machinery, or other heavy-duty applications.

EMBLEM OF INCO SERVICE
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○ Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes and other alloys containing Nickel. This information and data are yours for the asking. Write for "List A" of available publications.

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A ball bearing has a life-line, too. This life-line is well defined in the physical make-up of each of the bearing's component parts. That's why you see only *through-hardened,* chrome alloy precision balls and high-grade, carburized, hardened and tempered cold-rolled steel rings in Schatz "Commercial" Ball Bearings.

High fatigue resistance, added load capacity for the tougher jobs and an unusually wide application range are the end results of this inherently sturdy construction.

Schatz Bearings are engineered and manufactured in every standard type and size to deliver friction-free performance at low initial cost. Service requirements which vary from stokers to vacuum cleaners, bicycles to chain hoists, bulldozers to portable tools are all in a day's work for "Commercials."

Call on Schatz "know-how" to help fit this multi-purpose bearing to your needs. Then compare its on-the-job performance with other low-cost ball bearings.

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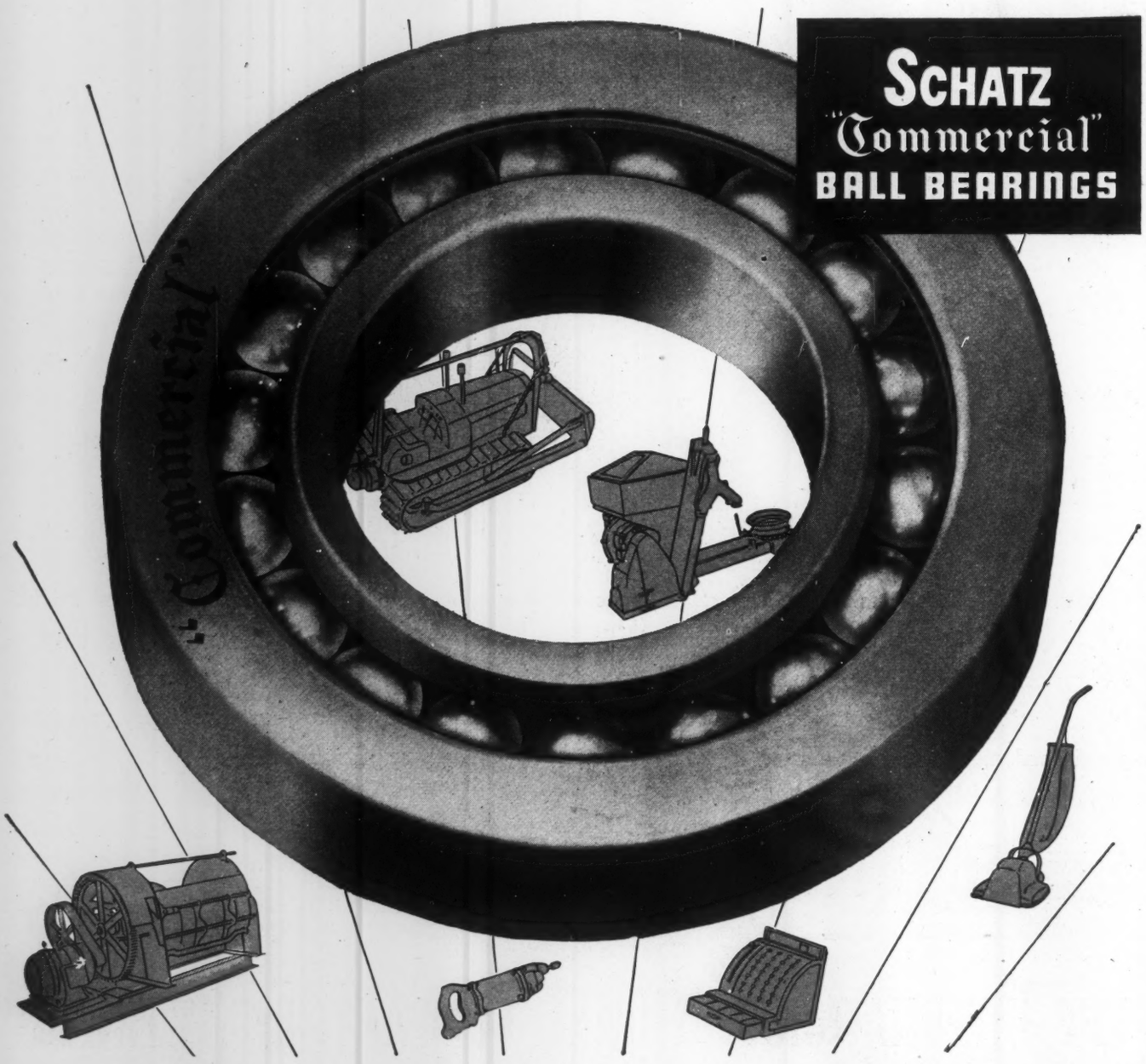
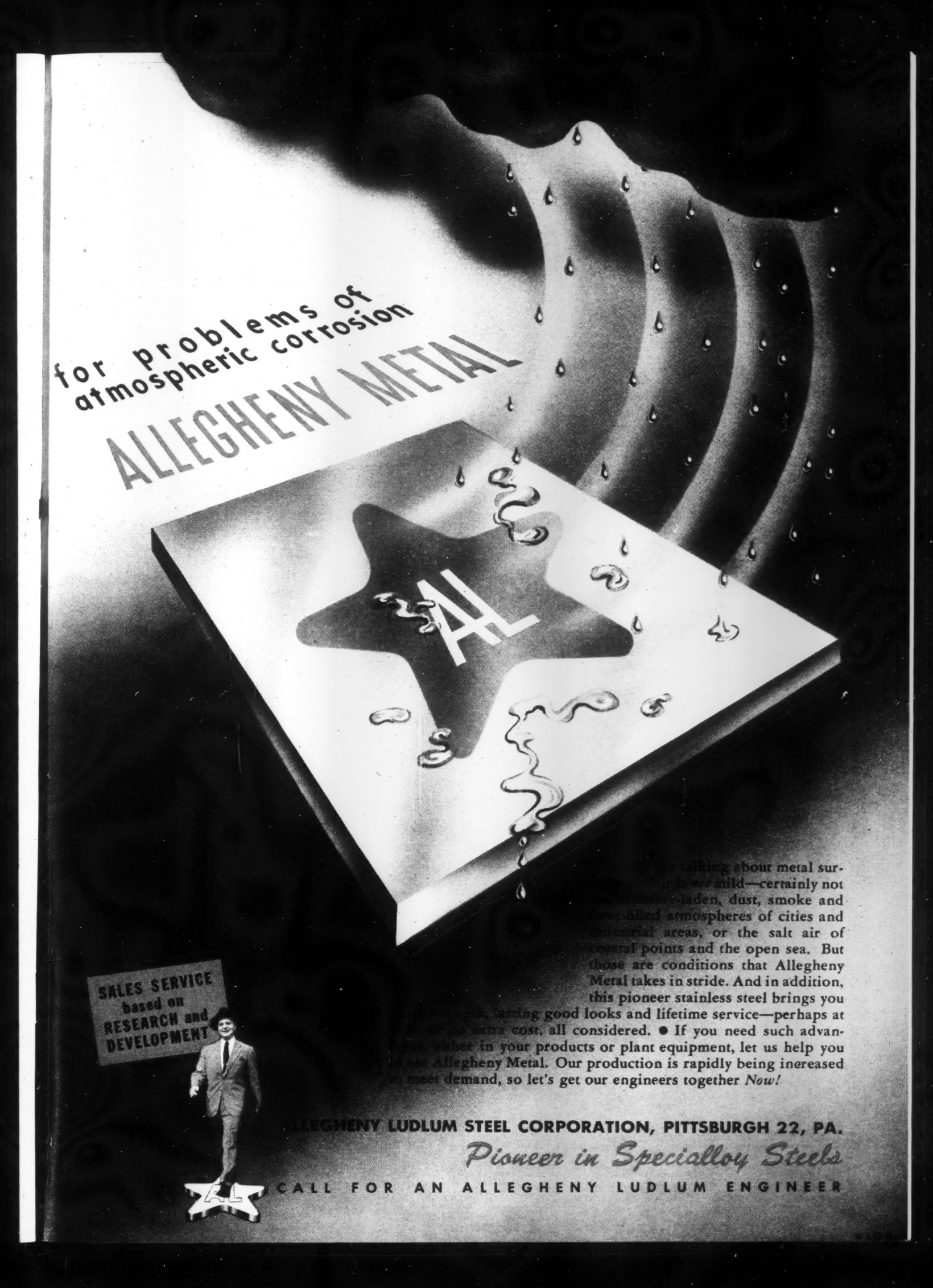
SCHATZ
"Commercial"
BALL BEARINGS



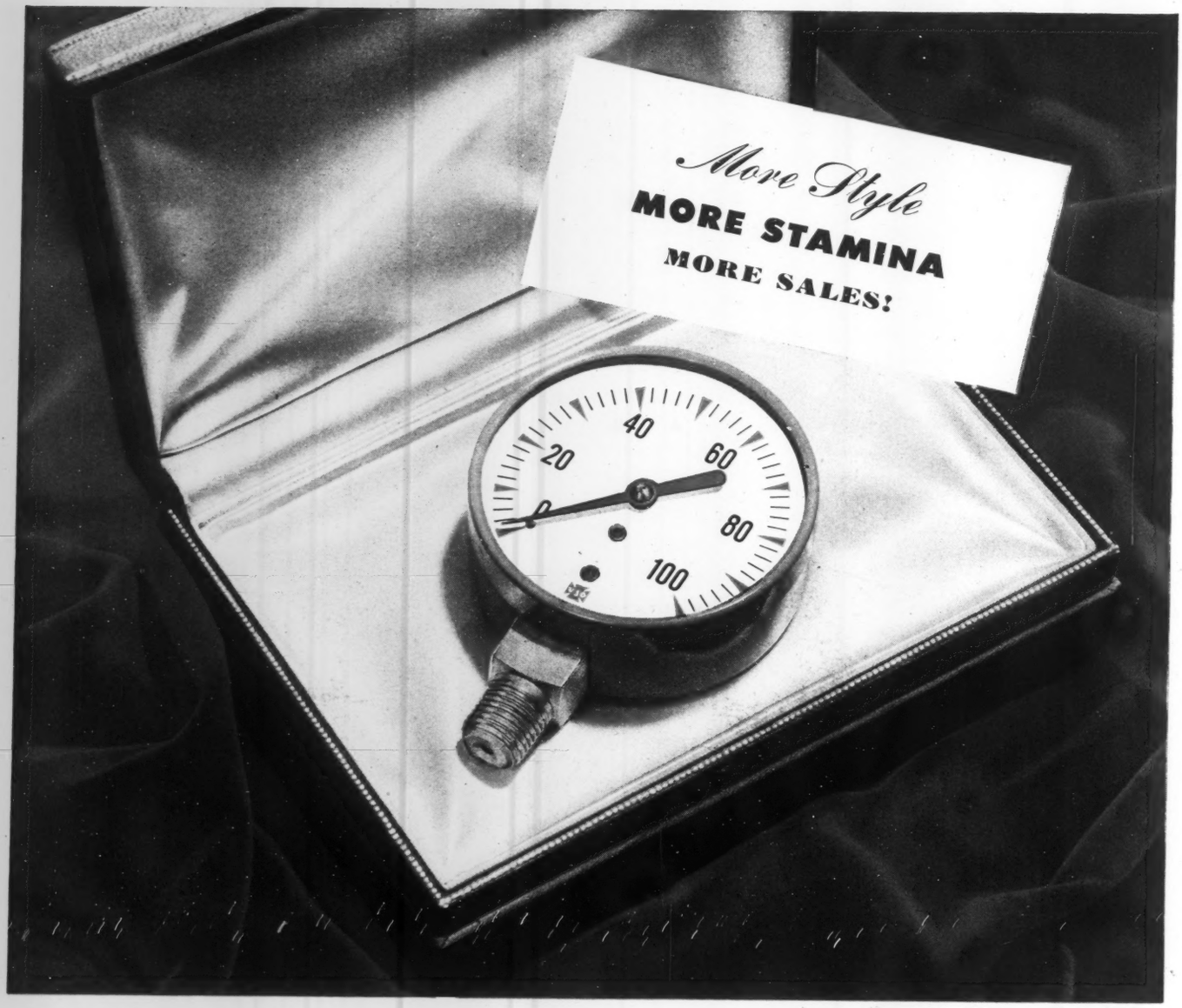


talking about metal sur-
mild—certainly not
laden, dust, smoke and
filled atmospheres of cities and
industrial areas, or the salt air of
coastal points and the open sea. But
those are conditions that Allegheny
Metal takes in stride. And in addition,
this pioneer stainless steel brings you
lasting good looks and lifetime service—perhaps at
or no extra cost, all considered. ● If you need such advan-
either in your products or plant equipment, let us help you
Allegheny Metal. Our production is rapidly being increased
meet demand, so let's get our engineers together *Now!*

ALLEGHENY LUDLUM STEEL CORPORATION, PITTSBURGH 22, PA.

Pioneer in Specialloy Steels

CALL FOR AN ALLEGHENY LUDLUM ENGINEER



YES, THIS NEW LINE OF U.S.G. gauges is three ways ahead. It's way out in front in appearance, styled by top American designers. It's improved inside to lengthen life yet retain famous U S G accuracy. It's a line of gauges that will make your product look even better and sell faster.

UNITED STATES GAUGE, SELLERSVILLE, PA.

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DIVISION OF AMERICAN MACHINE AND METALS, INC.

Manufacturers of Pressure, Temperature, Flow and Electrical Measuring Instruments

The Heavier Load is in the package, too!

Physical-fitness is a vital "dimension" in a ball bearing when it has a heavy-duty job to do. And it calls for the right degree of resilience, toughness and resistance to compression and distortion...with no sacrifice of precision.

Hardening the race rings *right through to the core* is Federal's way of "building-in" the needed strength to withstand the severe pressure of the ball on the ball track, particularly under heavy load. Automatic electric controls insure a uniform heat-treat throughout the entire Federal hardening cycle, while a percentage of each lot of rings is crush-tested to determine load-bearing strength. The fine grain of the fracture tells the "inside" story in inspection, but more important, adds long life to the bearing on the job.

Conditioning a Federal Ball Bearing for the tougher jobs is but one of over 100 individual production, inspection and cleaning operations that go into a single-row radial bearing. *With every fourth operator an inspector,* you may be sure that Federals are right *wherever tolerances are tight.*

Specify Federal Ball Bearings for the heavy loads—in any range or size.

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Makers of Fine Ball Bearings

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FEDERAL BALL BEARINGS

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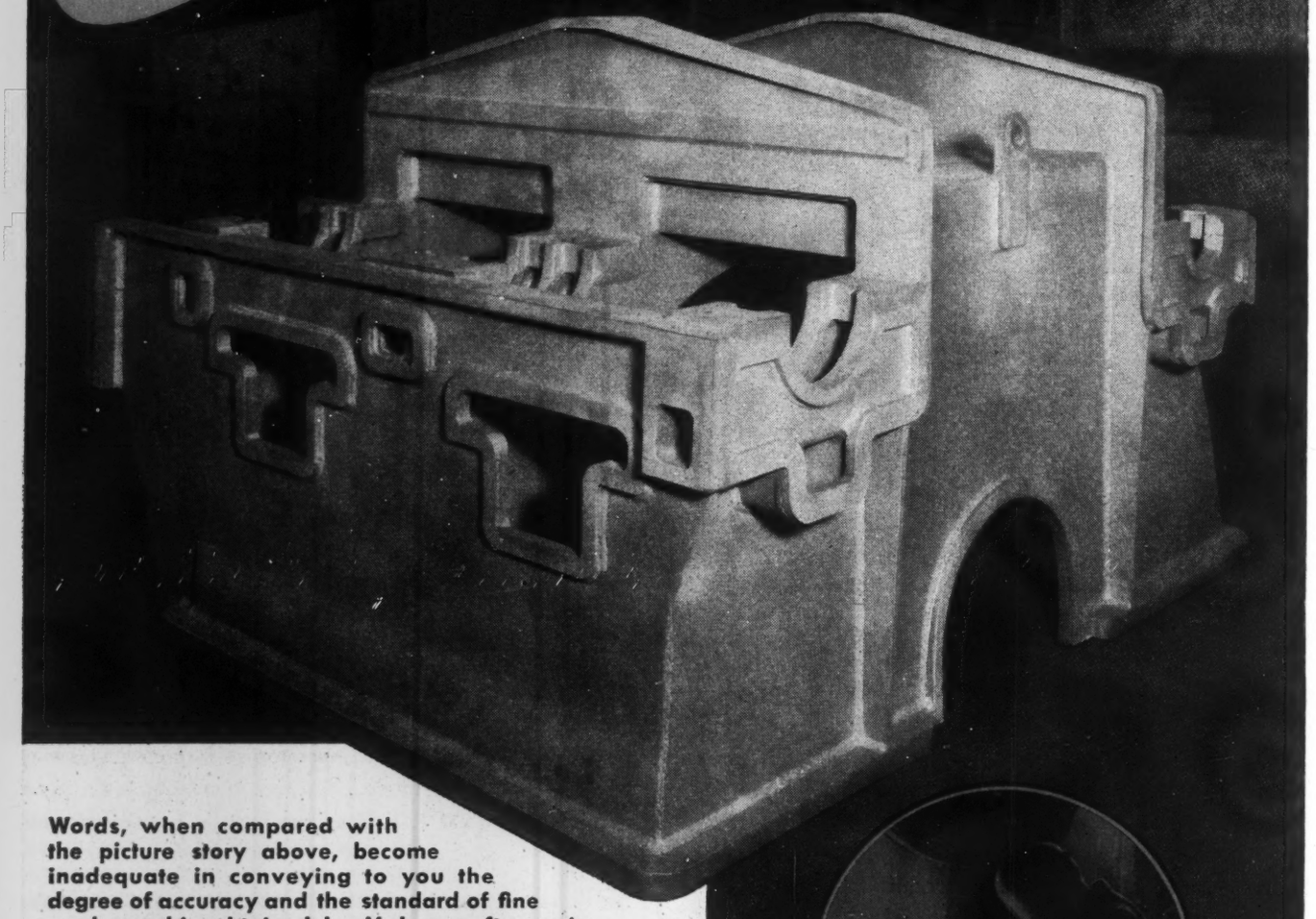
Steel-Weld FABRICATION



Words, when compared with the picture story above, become inadequate in conveying to you the degree of accuracy and the standard of fine workmanship obtained by Mahon craftsmen in the art of welding. Regardless of what your welded steel requirements may be, Mahon is your assurance of every advantage of Steel-Weld Fabrication.

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Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

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Tremendous load capacity...

is gained in heavy-duty trailers through the use of many closely spaced wheels, and is similarly secured in Torrington Needle Bearings

Through greater rolling contact surface.

Needle Bearings have a greater bearing contact surface because of the full complement of rollers. Consequently, they have a higher radial capacity than any other anti-friction bearing of comparable size.

In addition, these compact, high-capacity bearings are easily installed . . . retain lubricant efficiently . . . are low in cost. Let us help you secure their many advantages for your product.

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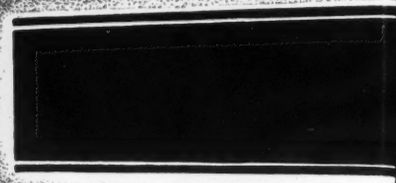
The Squeeze that ...with lower costs



You can produce cylindrical or ring-shaped parts faster and more economically from Rockrite Tubing than from commercial seamless tubing. Why? . . . because Rockrite Tubing is sized to closer tolerances, and with less eccentricity.

These factors result in more finished products per machine-hour. Machining is faster and costs less. In fact, many parts which, in the past, have been most economically turned out from bar stock can now be made out of Rockrite heavy-wall tubing with substantial production savings.

Here's how the Rockrite Process does it . . .

CLOSER TOLERANCES

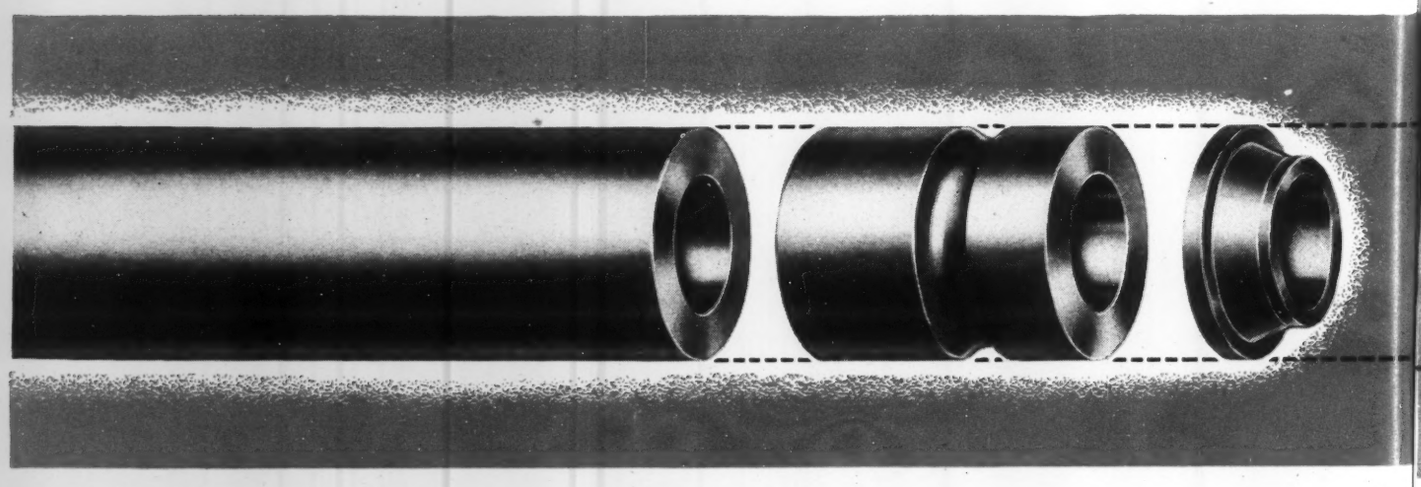
Rockrite Tubing is sized by compressing the metal by cold rolling in a controllable operation. Semi-circular grooved dies rock back and forth over the tube, compressing the metal against a mandrel which controls the inside diameter. This method—a complete departure from the cold-drawing process—permits tubing to be sized to closer tolerances. For example, 2″ O.D. Rockrite Tubing with .550″ wall thickness has less than one tenth the bore-tolerance of ordinary seamless steel tubing.

The Rockrite Process is adaptable to many grades and analyses of steel and other metals, including those which are difficult or impossible to cold-draw to size—and also to bi-metal tubing.

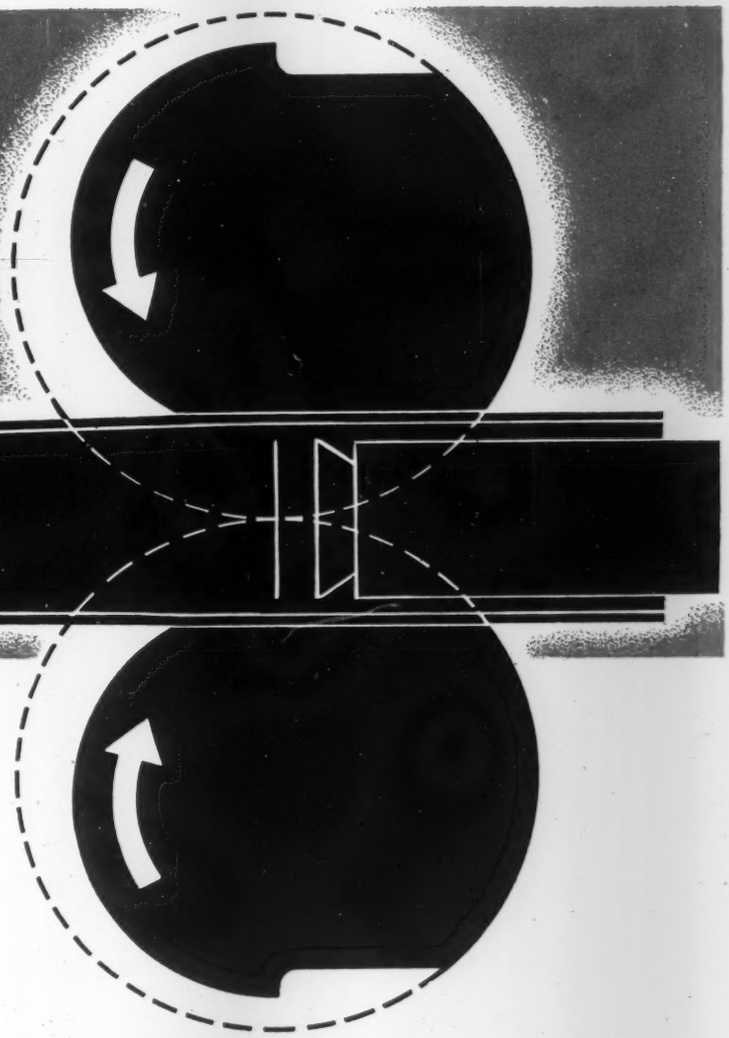
CONTROLLED CONCENTRICITY

In the Rockrite Process the tubing is sized by compression in progressive stages around the circumference of the tube. This causes the metal to flow *around* the tube as well as longitudinally, with a corrective action on any eccentricity or ovality that may be present in the tube before it is sized.

The greater concentricity and reduced ovality of Rockrite Tubing—particularly heavy-wall tubing—makes possible truly startling savings. In one plant the output of cylindrical parts was stepped



Pleases



up 60 per cent and the cost of machining cut in half when Rockrite Tubing was substituted for cold-drawn tube stock.

HIGH PHYSICALS

Working the metal by the Rockrite Process, as contrasted with stressing it in cold drawing, raises the physicals . . . and does it economically. For example, Rockrite Tubing of SAE X1020 can be produced without heat treatment, having 115,000 psi yield strength with 15 per cent elongation—and free machinability with these high physical properties. At the same time decarburization is minimized . . . worked down to such a thin layer as to be negligible.

You can get detailed information about Rockrite Close-Tolerance Tubing by sending for a 20-page descriptive bulletin which will be sent to engineers and executives who are interested in faster and more economical production of cylindrical or ring-shaped parts. Write today.

TUBE REDUCING CORPORATION

WALLINGTON
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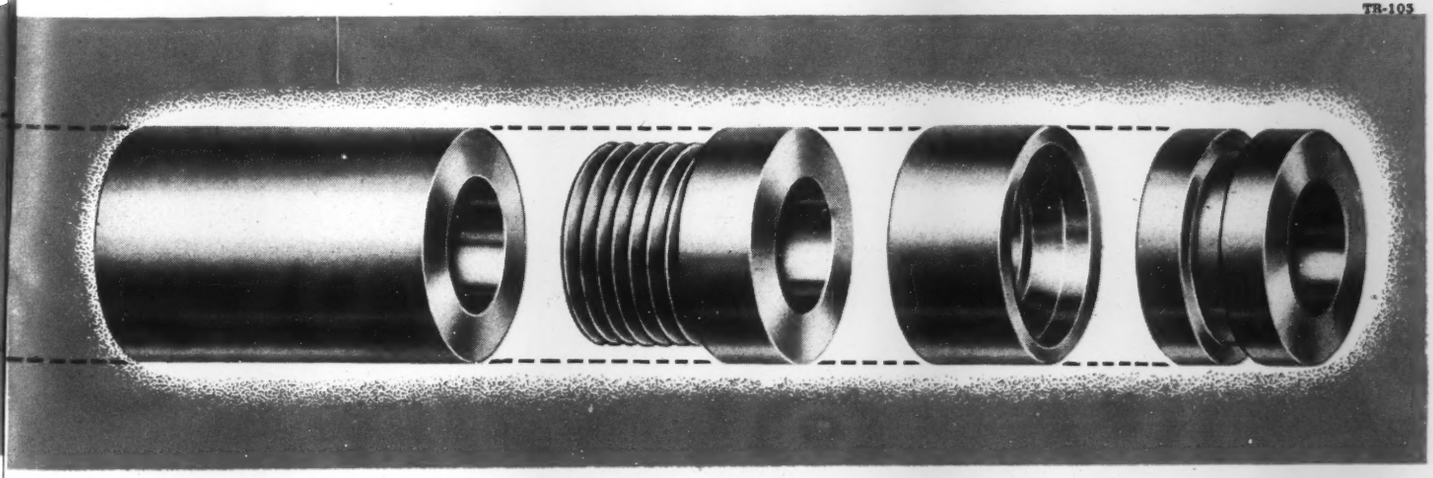
TR-105



Welded Steel Cuts Cost 27%

By C. D. Bonifield
Vice-President in Charge of Production
The Globe Company, Chicago, Ill.

IN our development program of continually improving the designs and production of our machinery for the meat packing industry, we have found it helpful to think in terms of arc welded steel construction. This affords a highly flexible approach to our problems and the end result is beneficial to the users of our products, the welded designs being strong, rigid, light-weight and of smooth, sanitary surfaces.

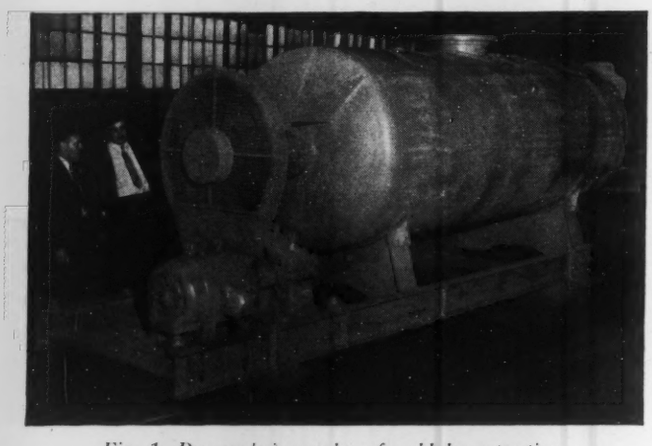


Fig. 1. Dry rendering cooker of welded construction.

One design which has been changed recently to welded steel construction is the saddle for the dry rendering cooker shown in Fig. 1. Two of these saddles support the welded pressure vessel on the welded base of this machine.

Fig. 2. Saddle support member of former design.

Fig. 3. Welded steel saddle costs 27% less than former design.

Fig. 4. Fixture used for assembly of welded saddle.

A saddle of former construction is shown in Fig. 2. The welded steel saddle, shown in Fig. 3, is produced at a total saving of 27% in cost over the former design.

The welded saddle, 60″ wide, 24″ high and 8″ deep, is fabricated from ½″ mild steel plate, consisting of four pieces, flame-cut and brake formed. The parts are assembled in the welded fixture shown in Fig. 4, which is placed on a work table in the flat position. After tack welding the parts together, the assembly is removed from the fixture and finish welded as shown in Fig. 5, with the saddle positioned for downhand welding of all joints. This requires continuous, two-pass fillets on both sides to join the flange to the web. The end pieces of the flange are butt-welded on both sides to the top flange assembly.

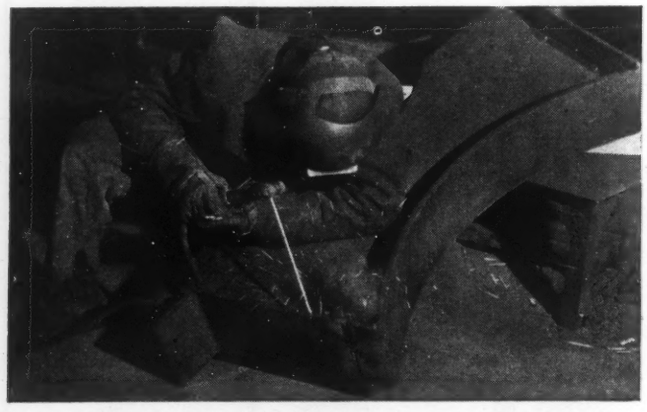
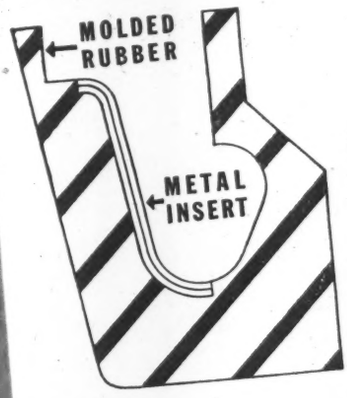


Fig. 5. Joints are positioned for downhand welding.

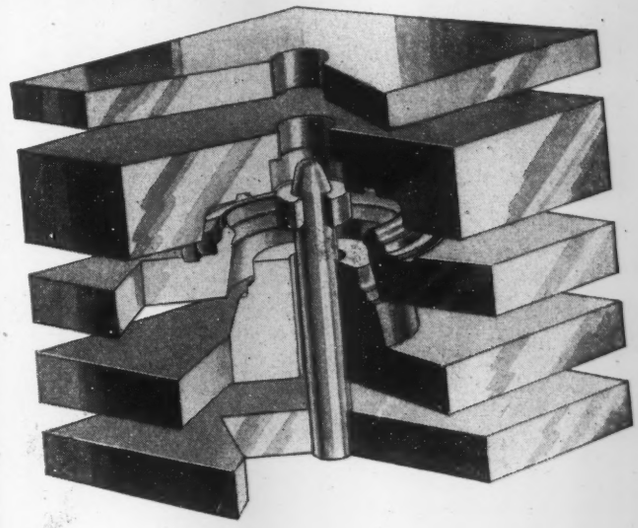
In approaching designing problems, our engineers have been aided by the Studies in Machine Design published by Lincoln Electric. These can be secured by writing to THE LINCOLN ELECTRIC COMPANY, Dept 353, Cleveland 1, Ohio.

Advertisement



"SIMPLE" PARTS

The relatively "simple" rubber-to-metal part indicated by the cross-sectional drawing above requires the complex, multiple-cavity mold illustrated at the right.



often demand

COMPLEX MOLDS

The "simple" rubber-to-metal part is not necessarily free of complications in producing it. As the above example illustrates, an intricate, multiple-cavity mold is required to produce the part that looks so "simple."

First consideration is the combination of conditions under which the finished part is to function. Next comes the design and manufacture of the mold to produce it. Then the correct compound of rubber or rubber-like material must be determined to meet both the molding and functional requirements. Exceptional precautions must be taken to prevent heat expansion from causing variations in the mold cavities, and often the mold cavities have to be registered individually with each other. Those and other related problems must be brought into "harmony" by modern techniques of the rubber industry. Briefly, it is a combination of "know-how" factors available here at "ORCO" that is causing an unprecedented demand for our services from a wide diversity of industries.

THE OHIO RUBBER COMPANY

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Factories: WILLOUGHBY, OHIO • LONG BEACH, CAL. • CONNEAUTVILLE, PA.

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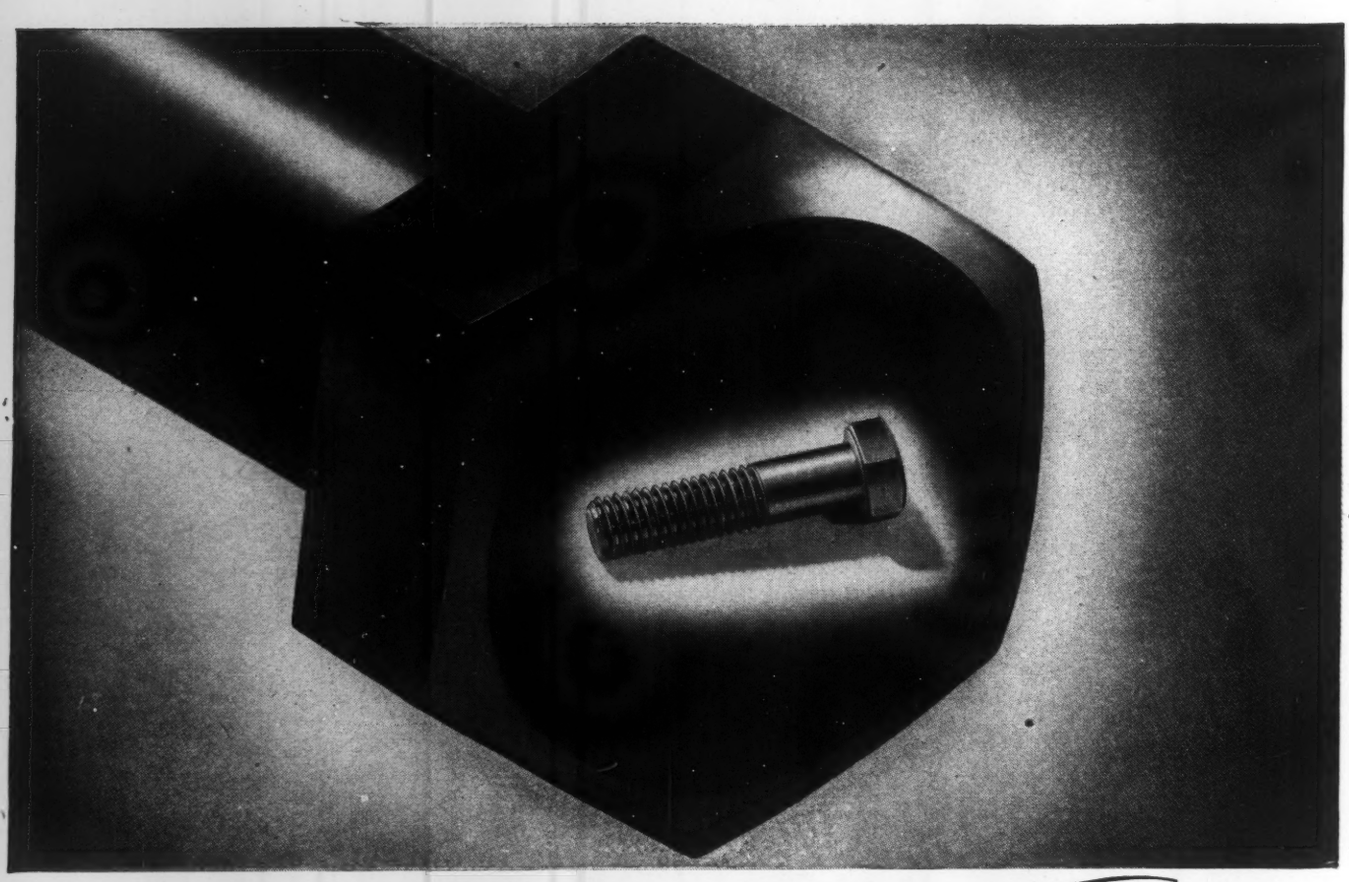

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You Get T. F. E. *When You*

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2. Make your men happier by giving them fasteners that make their work easier
3. Reduce need for thorough plant inspection, due to confidence in supplier's quality control
4. Reduce the number and size of fasteners by proper design
5. Purchase maximum holding power per dollar of initial cost, by specifying correct type and size of fasteners
6. Simplify inventories by standardizing on fewer types and sizes of fasteners
7. Save purchasing time by buying larger quantities from one supplier's complete line
8. Contribute to sales value of final product by using fasteners with a reputation for dependability and finish

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102 years making strong the things that make America strong

RB&W bolts, nuts, screws, rivets and allied fastening products are manufactured in a broad range of styles, sizes and finishes.

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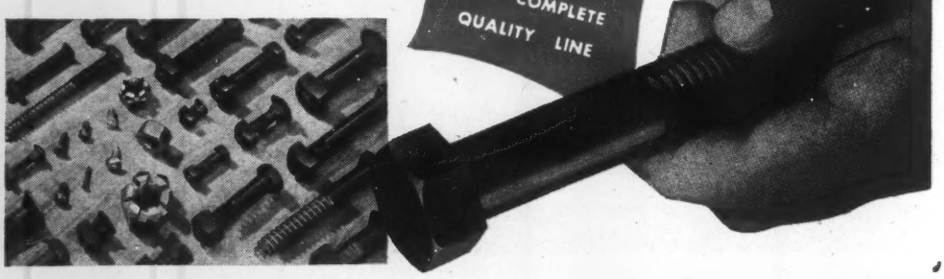
Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Chattanooga, Portland, Seattle. Distributors from coast to coast. By ordering through your distributor, you can get prompt service from his stocks for your normal needs. Also—the industry's most complete, easiest-to-use catalog.



Here's where you can cut production costs!

The external upset operation being completed on this section of OSTUCO Seamless Steel Tubing will cut production time and costs in the final machining process in the customer's plant. This is just one of the many forming operations performed by The Ohio Seamless Tube Company—operations that conform exactly to the customer's blueprints and specifications.

Our sales engineers will gladly show you how the uniform quality and machinability of OSTUCO Seamless Steel Tubing, formed to your exact requirements, will simplify the manufacture of your product. Our skilled craftsmen, world-famous for their deftness in forming seamless steel tubing, will help make yours a better product.

Complete information is available, without obligation, at the nearest sales office.

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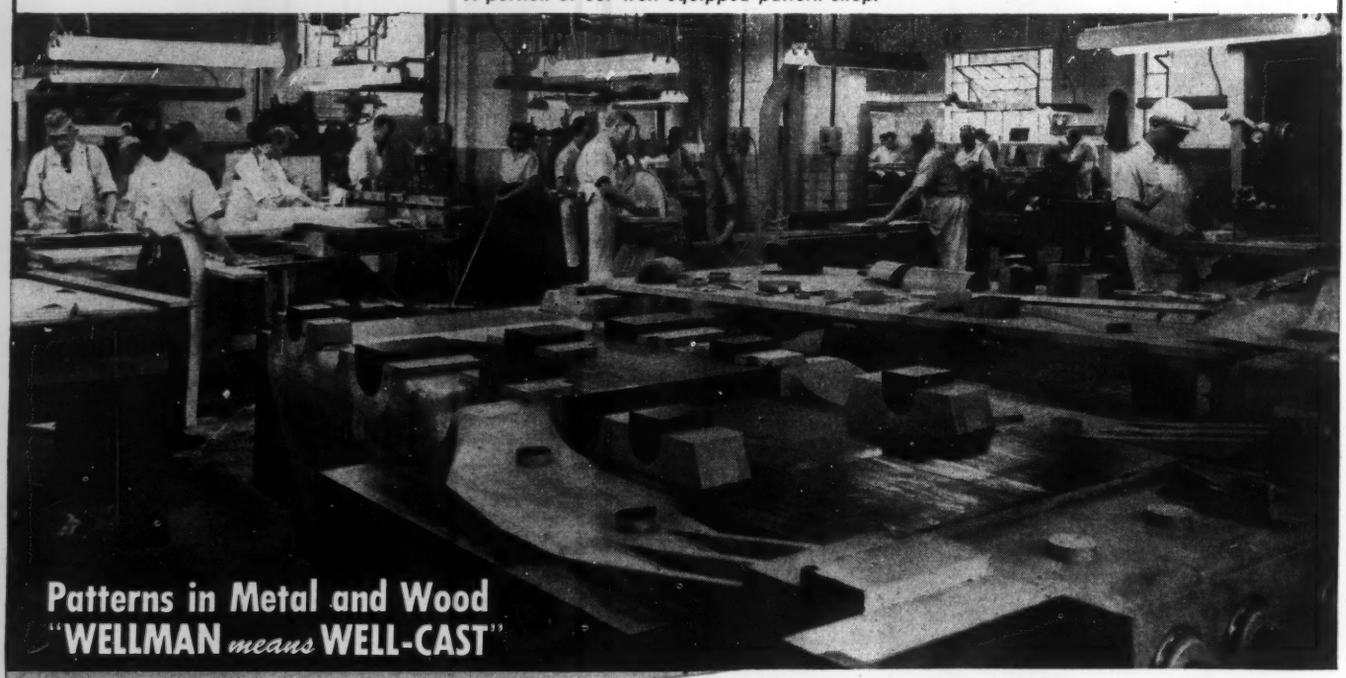
Send blue prints for quotation or let us know and we shall be glad to have a representative call.

A portion of our well-equipped pattern shop.



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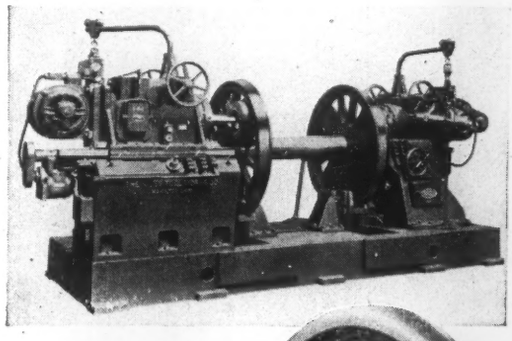
Why do so many manufacturers use and prefer Timken Bearings?

In practically every major industry Timken Tapered Roller Bearings are the first choice of engineering executives.

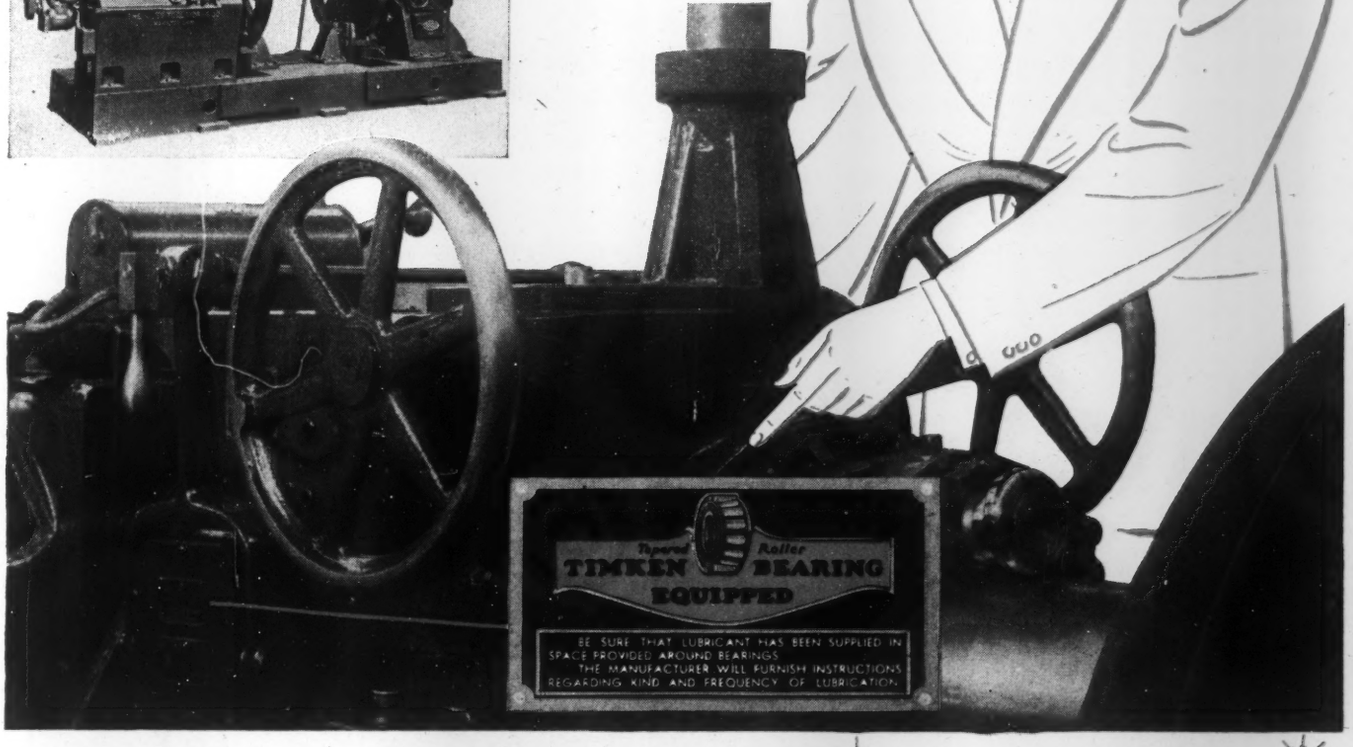
They are to be found delivering amazing performance in every kind of machinery — in gigantic steel mills, machine tools, construction equipment, oil field equipment, paper-making equipment — in fact wherever wheels and shafts turn.

Timken Bearings likewise are preferred by sales executives, but for a different reason. They have found it is easier to sell any kind of machine when they tell their prospects it is Timken Bearing Equipped, for the trade-mark "TIMKEN" means "All there is in bearings" the world over.

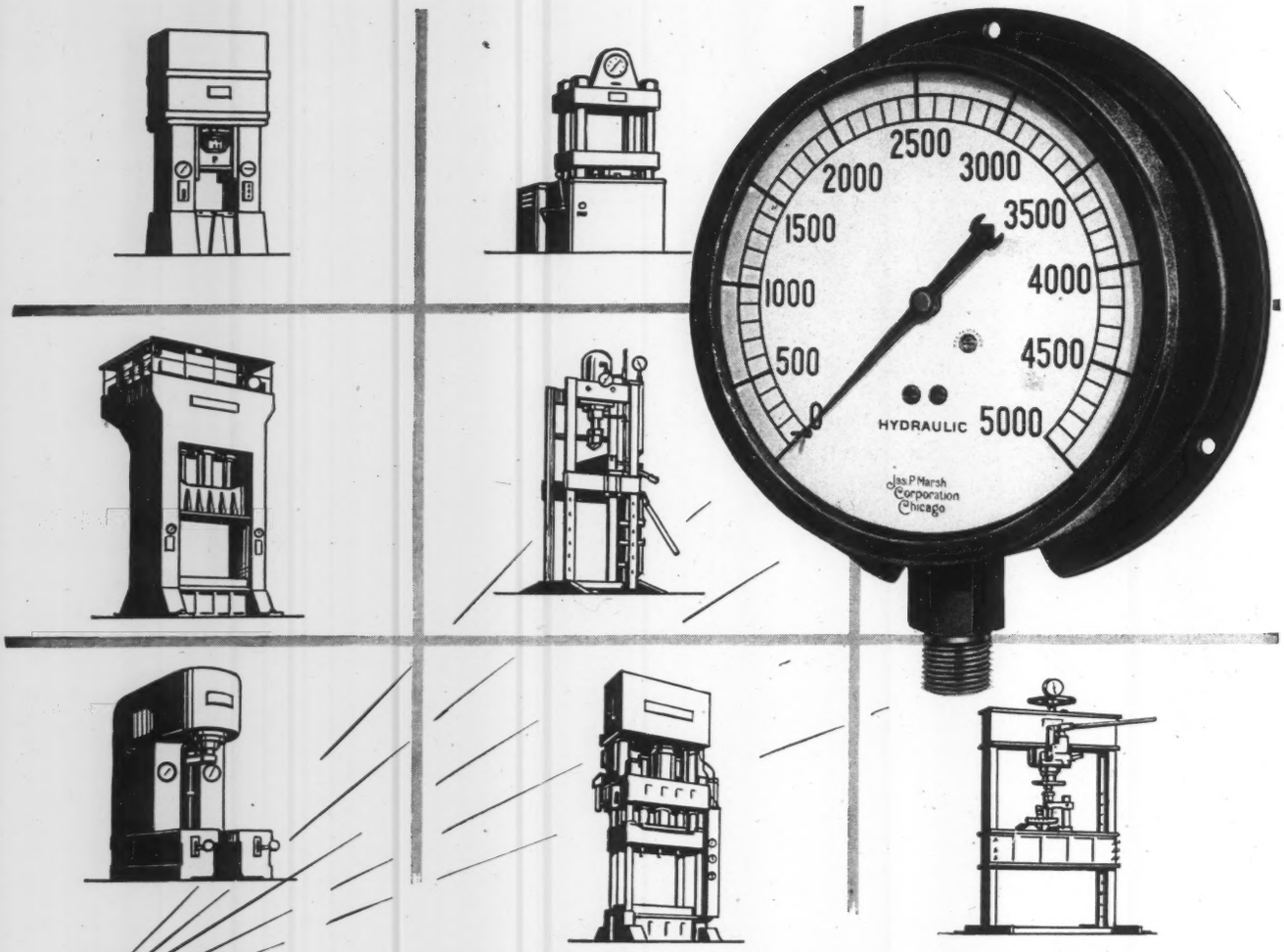
Thus when you buy Timken Bearings you know you will have the enthusiastic approval of everyone concerned. The Timken Roller Bearing Company, Canton 6, Ohio.



Photograph shows the improved NILES Balanced Quartering and Crankpin Turning Machine performing a burnishing operation on a railroad locomotive driving wheel crankpin.



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST ⊣◎⊢ LOADS OR ANY COMBINATION ⊣◎⊢



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. . . by 59 leading makers of hydraulic machinery

Hydraulic service imposes extra-heavy demands on pressure gauges. Applied to hydraulic machinery, gauges must be extremely accurate, yet sufficiently rugged to stand up under the high pressures and unpredictable shocks which characterize hydraulic operation.

As a result, manufacturers in this field are highly critical in selecting gauges. So there could be no more impressive tribute to Marsh quality and stamina than the preference accorded Marsh Gauges in this particularly difficult field.

Here is a field in which firms are large in size, but small in number; yet Marsh Gauges are currently used by 59 leading manufacturers whose output, conservatively estimated, represents a substantial majority of the nation's production of hydraulic machinery. The products include every type of equipment—testing, lifting, forging, forming, broaching and forcing presses applying pressures up to thousands of tons.

Yes, the designers of hydraulic equipment have recognized in Marsh Gauges the same combination of qualities that they have so well mastered in their own equipment—the combination of accuracy *and* stamina. A significant tribute, this, but merely one more example of the preference accorded Mash Gauges, in *many* fields.*

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Export Dept.: 155 E. 44th St., New York 17, N. Y.

Jas. P. Marsh products include: A full line and range of gauges in pressure, compound, altitude, hydraulic, sprinkler, ammonia, ounce-graduated retard, test, and diaphragm types. Dial thermometers in rigid stem and remote reading types. A broad line of steam and hot water heating specialties. Ask for literature.

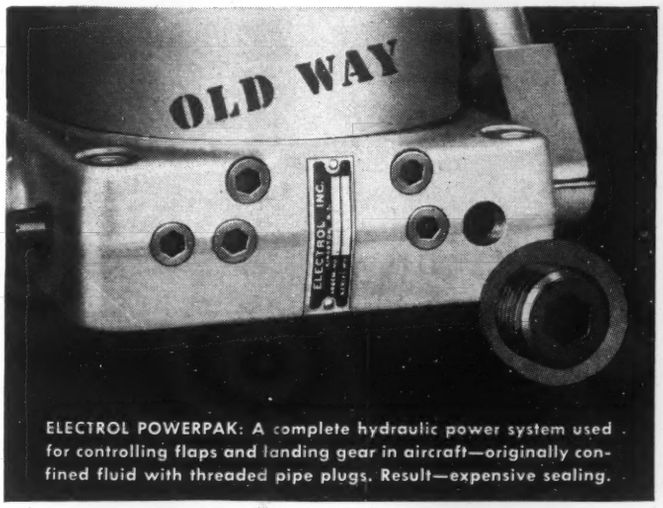
MARSH ALONE HAS THE "RECALIBRATOR"
—quickest and best way to correct a gauge that has been knocked out of adjustment by improper handling.

MARSH GAUGES

"THE STANDARD OF ACCURACY"

*Subsequent advertisements will cite additional examples of this.

Redesign eliminates 12 operations, reduces Unit Cost 65 cents



ELECTROL POWERPAK: A complete hydraulic power system used for controlling flaps and landing gear in aircraft—originally confined fluid with threaded pipe plugs. Result—expensive sealing.

NEW DESIGN: Waldes Truarc rings provide positive seal up to 3000 P.S.I. for plugs without threads. Changeover eliminated two milling, ten tapping operations. Result—inexpensive sealing.

Redesign with Waldes Truarc rings not only saved us 65 cents a unit and 6¼ minutes production time, it made a more compact and finer product—reports Electrol, Inc., of Kingston, N. Y. Truarc helped cut 4 ounces a unit, eliminated milling and tapping, allowed switching from skilled to semi-skilled labor. Maintenance was cut more than a half.

Redesign with Truarc, and you will cut costs and increase production, too. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Waldes Truarc retaining rings are precision engineered, easy to assemble and disassemble, always circular to give a never-failing grip. They can be used over and over again. Send us your problem. Waldes Truarc engineers will be glad to show how Truarc can help you.

15 Waldes Truarc Retaining Rings effect these Savings

	SAVING
• Eliminate 2 milling operations . .	$.10
• Replace 10 tapping operations with grooves	.15
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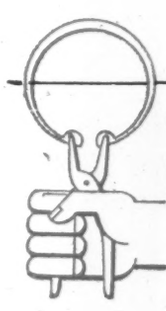
• Replace pipe plugs with plugs made in automatics	.16
• Cut plug assembly time over 50%	.15
• Reduce production test time . . .	.06
Total savings per unit . .	**$.65**



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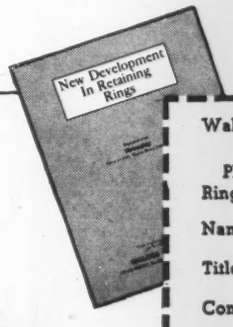

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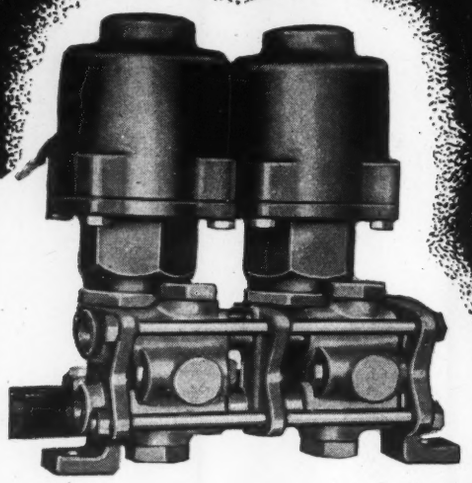

Group-mounted solenoid pilot valves save space, improve appearance, simplify piping.

Dependable *electric* control of steam, air, or hydraulic flow is assured with ASCO Solenoid Pilot Valves. Because they operate instantly on standard voltages, these valves are ideal for automatic cycle control and for many types of remote control installations.

Consider these versatile ASCO Solenoid Valve Types:

3-Way Direct-Operated Pilot Valves . . . to control single or double acting pneumatic or hydraulic cylinders, and diaphragm operated power heads on machinery and similar applications.

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4-Way Pilot Valves . . . in two designs: (1) balanced piston, direct solenoid operated, for liquid or air where tight seating is not required; (2) poppet type, diaphragm operated with solenoid control, for tight seating with liquids or air.

Group Mounted Valves . . . for more compact installation, neater appearance, and fewer piping connections.

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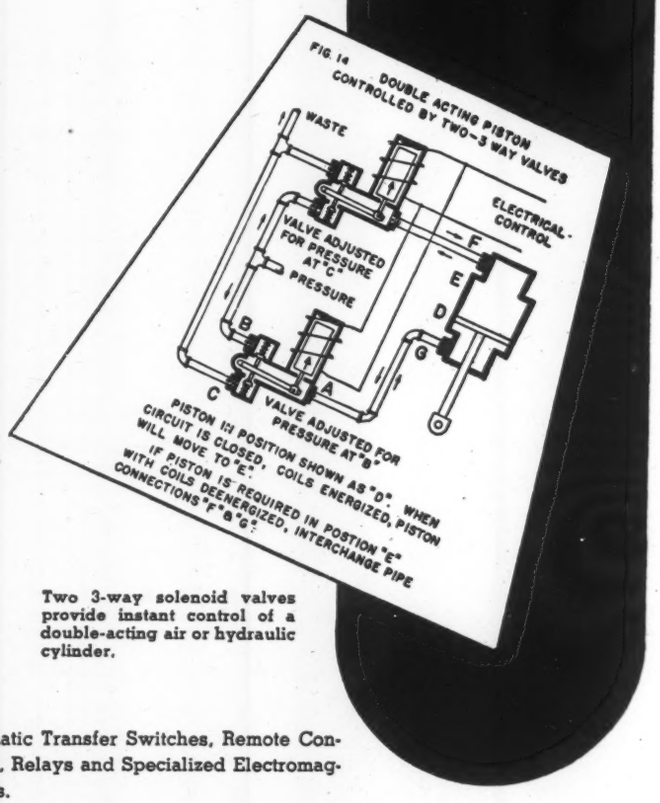

Two 3-way solenoid valves provide instant control of a double-acting air or hydraulic cylinder.

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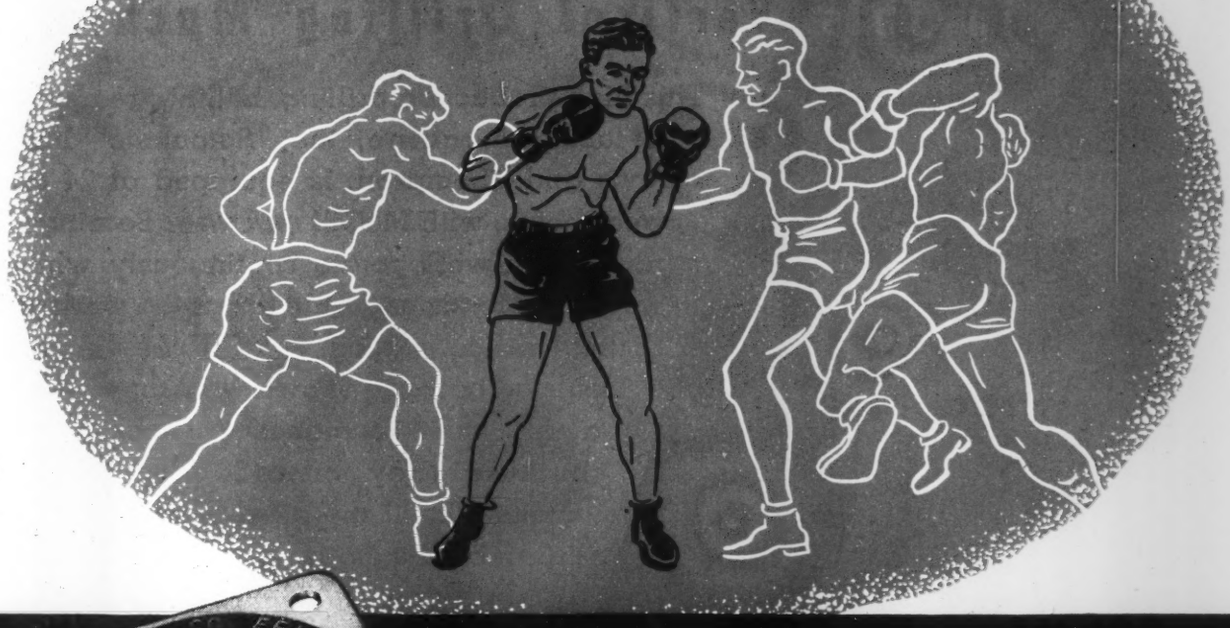
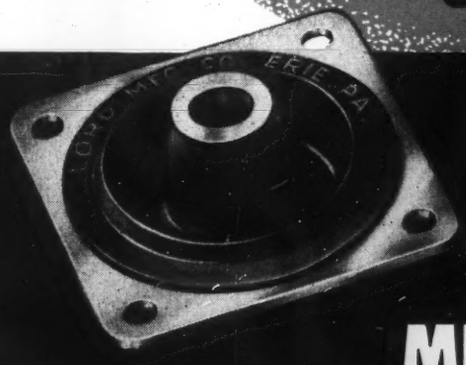
From All Directions





Isolate It Completely with NEW LORD MULTIPLANE MOUNTINGS

a new standard of product performance . . .

Vibration now can be isolated from your product, through a greater range of frequencies *regardless of the direction of disturbing forces* . . . with new MULTIPLANE MOUNTINGS pioneered by Lord. Here, then, is a brand new standard of vibration control . . . and a brand new opportunity to boost performance standards and product sales.

Lord MULTIPLANE MOUNTINGS not only provide all-directional freedom—universal softness in all planes—but are simple, compact, one-piece mountings that give your design engineer the plus advantages of complete protection with less weight, easy installation, at very reasonable cost.

Like all Lord Products, MULTIPLANE MOUNTINGS feature the same *permanently-bonded-rubber-in-shear* principle that has made Lord first in the field of Vibration Control and Bonded Rubber Products. Put this specialized experience, backed by Lord research and engineering, to work on your problems. We'll be only too glad to serve you.

For more information write for Bulletin 106

LORD MANUFACTURING COMPANY ERIE, PA.

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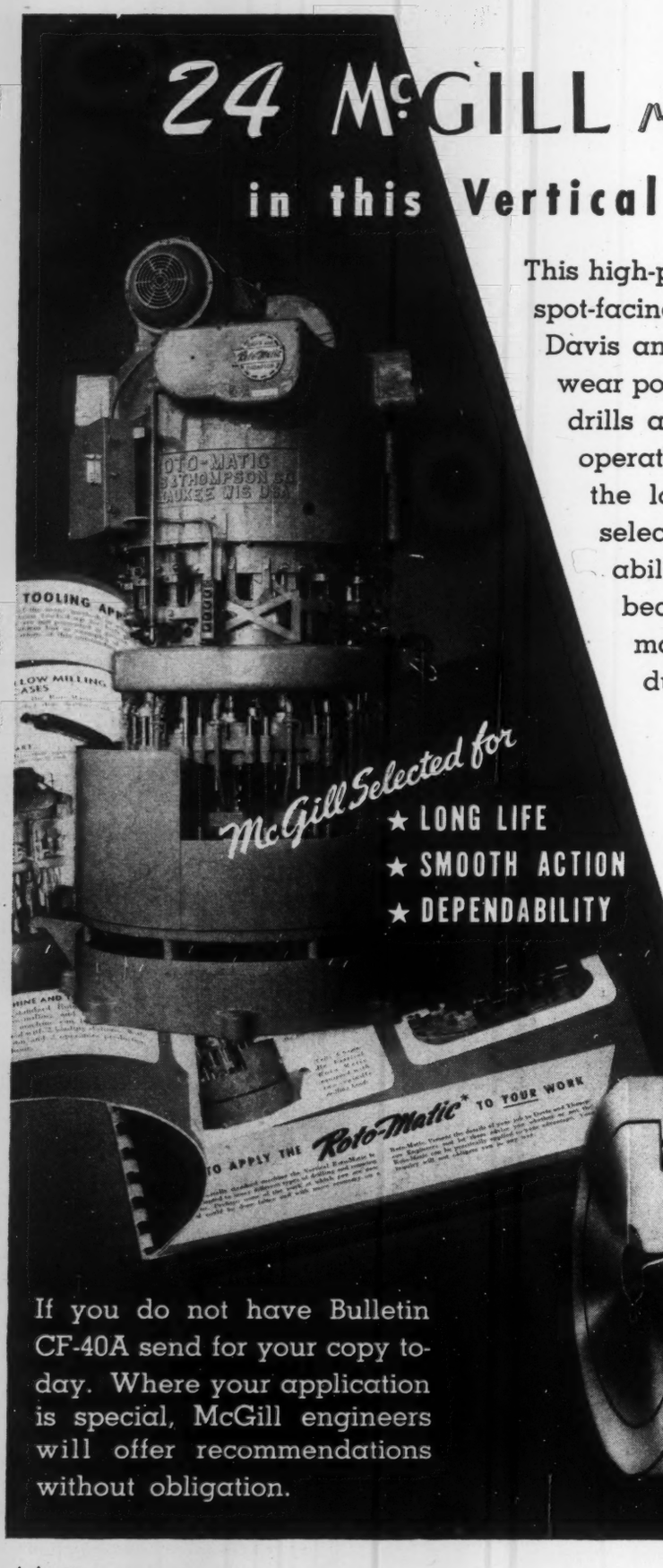
Canadian Representative: Railway & Power Engineering Corp., Ltd., Toronto, Canada.

Lord MULTIPLANE MOUNTINGS are ideal for instruments, electronic equipment, and other devices of high sensitivity, not to mention other applications including engine-generator sets, air-conditioning units, pumps, blowers, etc. Features like these insure vastly improved performance:

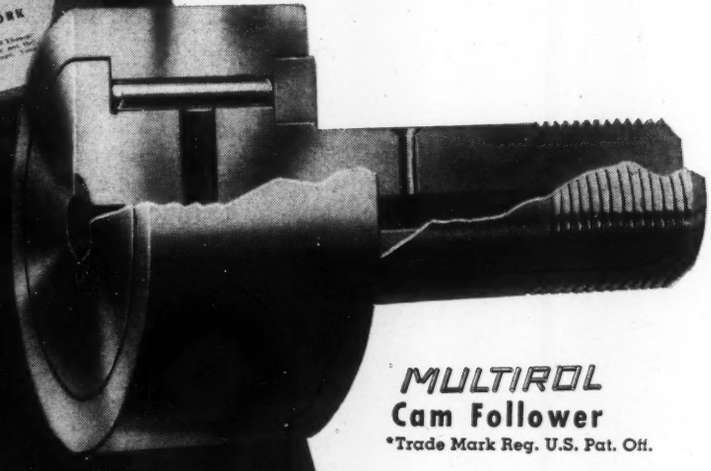
- **Simple, low-weight, one-piece construction.**
- **Easy, convenient, low-cost installation.**
- **Long life thru large bonding area—low bond stress.**
- **All-directional softness from multiple shear areas.**
- **Progressive cushioning of shockloads by snubbing shoulder.**

24 McGILL MULTIROL* BEARINGS in this Vertical Drilling Machine



This high-production drilling, milling, reaming and spot-facing machine, the "Rotomatic" built by Davis and Thompson, is equipped at 24 critical wear points with McGill MULTIROL Bearings. The drills and work rotate continuously while the operator loads and unloads as the work passes the loading station. McGill bearings were selected because of their well-known dependability, their resistance to shock load, and because they offered advantages that make McGill the ideal bearing for heavy duty applications.

Whether you are designing machine tools or some other precision-built product you can depend on McGill Bearings to give you precision accuracy, adequate lubrication facilities, high load capacity for size and all the other essentials of better bearing performance.



MULTIROL
Cam Follower
*Trade Mark Reg. U.S. Pat. Off.

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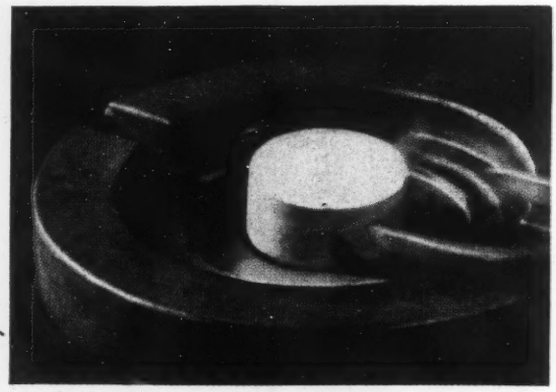
Anaconda HOT PRESSED FORGINGS
made by The American Brass Company

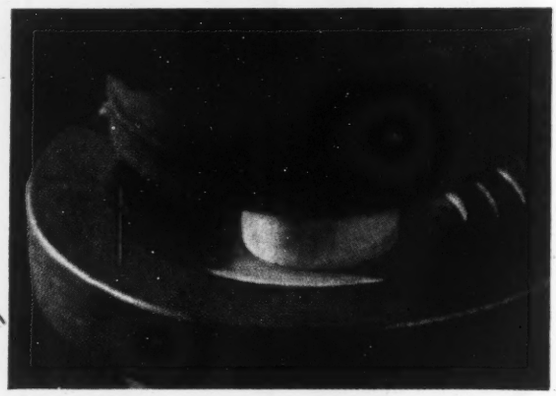
Illustrating the almost unlimited design possibilities in producing complicated or intricate parts of wrought Copper, Brass, Bronze or Special Copper Alloys. Additional information regarding this product appears on the following page.

Machined samples through courtesy of customers.

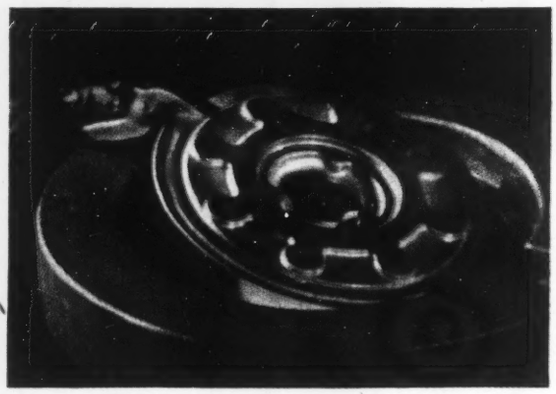
Here's how Anaconda Hot Pressed Forgings are made



1 a heated copper-alloy blank is centered in the die . . .



2 the dies close—with hundreds of tons of pressure . . .



3 and presto! — the metal is wrought into a semi-finished shape.

Of course, it isn't quite that simple. There are such matters as alloy composition, forging temperature, die design, trimming, piercing or sizing — but these are problems that we take care of.

and here's how they improve the product, reduce the cost

Anaconda Hot Pressed Forgings have twice the strength of sand castings—without the sand that causes needless tool wear. Absence of internal defects and a uniform, dense grain structure make them gas, air and watertight—able to withstand high pressures. Consistently accurate in dimension, they have a smooth, fine-textured surface and machine readily. Available in Copper, Brass, Bronze and Special Copper Alloys.

For typical examples of Anaconda Hot Pressed Forgings, see the preceding page. Inquiries regarding specific metallurgical, design, cost or production information will be given prompt attention. 45161

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA *Anaconda Hot Pressed Forgings*

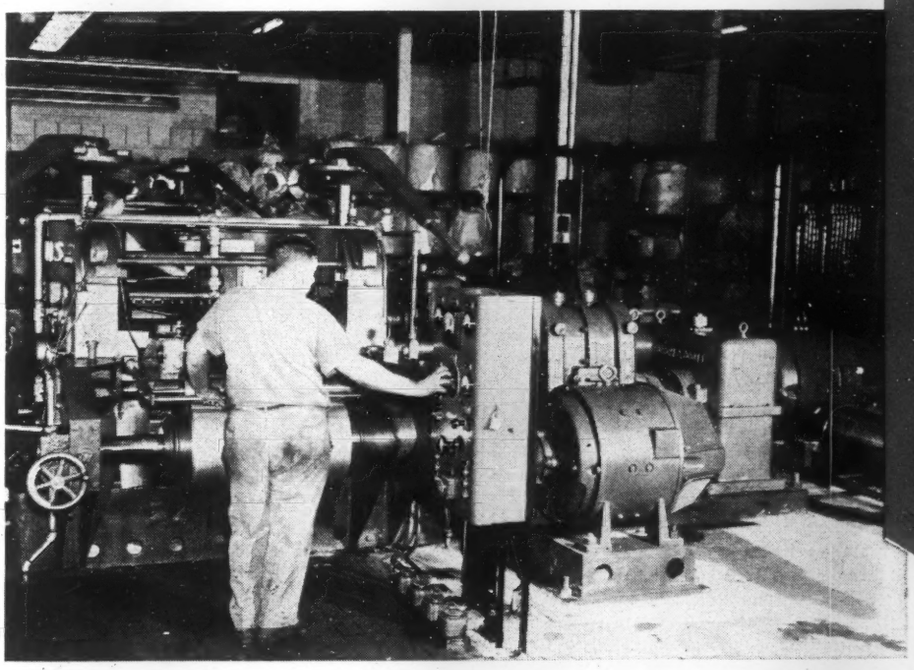
ADJUSTABLE SPEEDS FROM A-c. CIRCUITS

Plus

$25 to $60 SAVINGS

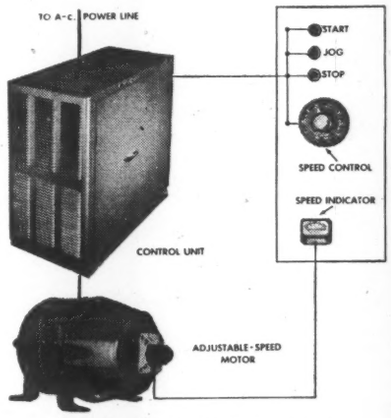
PER KILOWATT OF INSTALLED D-c. CAPACITY

with



RELIANCE V★S DRIVE

RELIANCE V★S DRIVE



Conveniently-packaged, space-saving V★S Drives are available from 1 to 200 hp.

Reliance V★S Drive gives you all the flexibility of machine operation you need for faster, better, lower-cost processing. This means an infinite range of stepless speed changes, quick, smooth starts and stops, reversal at any point desired and maintenance of proper tension . . . all from A-c. circuits. And with these advantages, you reap the PLUS of $25 to $60 savings per Kilowatt capacity by installing the factory-wired, conveniently-packaged V★S Drive instead of bringing in and applying D-c. power from a central source. For more money-saving facts about the V★S Drive, call your nearest Reliance Representative or write for Bulletin 311-A.

RELIANCE ELECTRIC & ENGINEERING CO.
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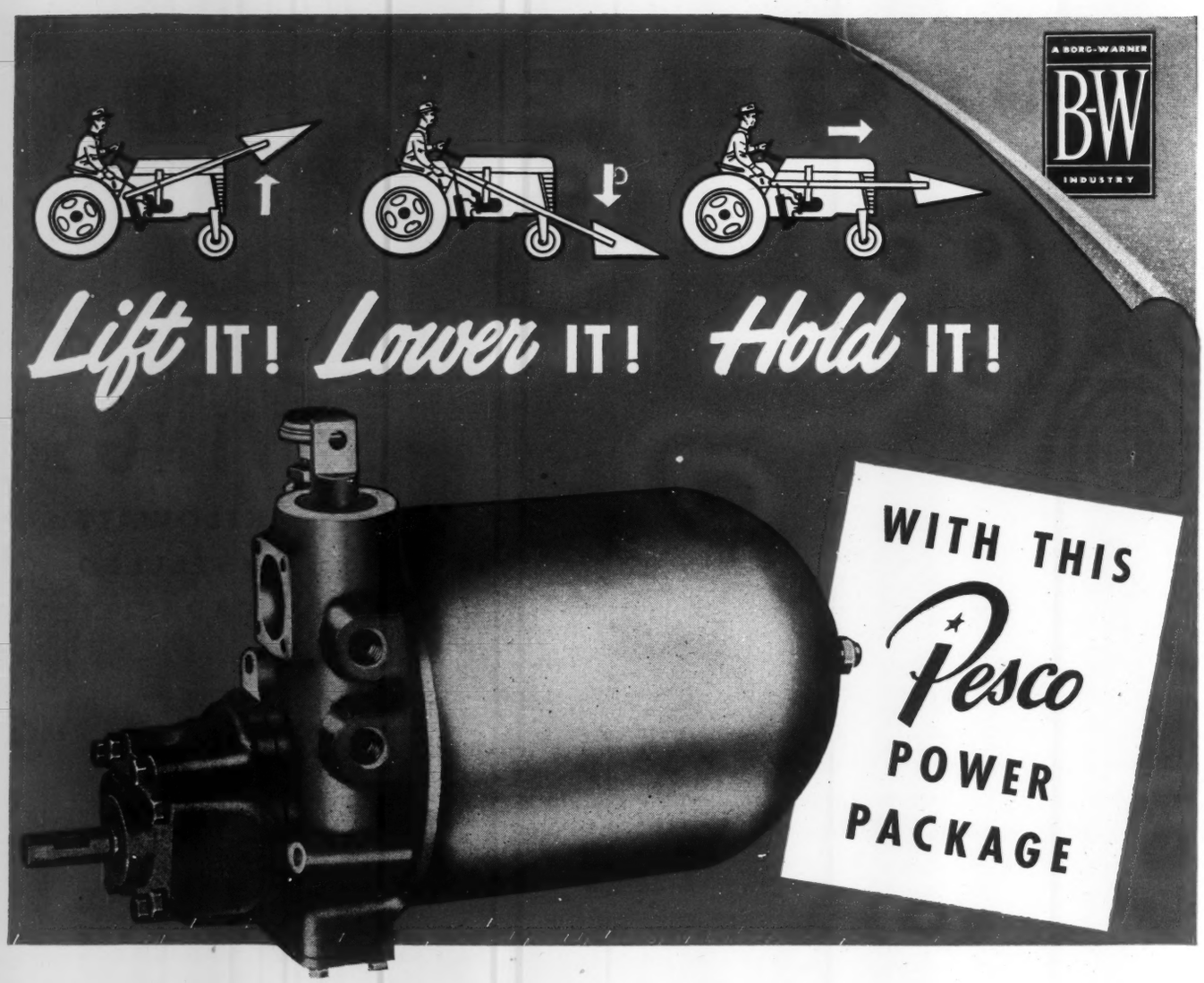
RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"



Whether it is a farm tractor, a manure loader, a bulldozer or an industrial lift truck, this new Pesco Power Package will lift, lower or hold the load exactly the way you want. It will raise or lower the load as rapidly or slowly as you wish and when you get it where you want it . . . a flick of the selector valve handle and the load stays put! Even if the motor stalls, the load stays where you put it . . . indefinitely. Also the load may be lowered even though the unit is not in operation.

This complete Pesco Power Package consists of a pump, selector valve, relief valve and reservoir. The pump has a capacity of 10½ g.p.m. at 2100 r.p.m. at 1200 p.s.i. and a volumetric efficiency of 90 per cent or better. It features the famous, exclusive Pesco development *Pressure Loading* that automatically compensates for wear and guarantees a long service life.

The selector valve is the open center type and can be made either a three-way or four-way valve by simply interchanging two plugs. The relief valve is factory set to relieve at 1500 p.s.i. The reservoir has a two-gallon capacity but can be easily changed to a larger or smaller size.

Its quiet operation and its simplicity of construction . . . it has a minimum number of parts . . . make this new Pesco Power Package particularly adaptable to a wide range of machinery applications. For complete information write for Bulletin No. 117 to Department 57-H.

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories and Aircraft Electric Motors . . . Performance Points to PESCO First.

Pesco PRODUCTS DIVISION
BORG-WARNER CORPORATION
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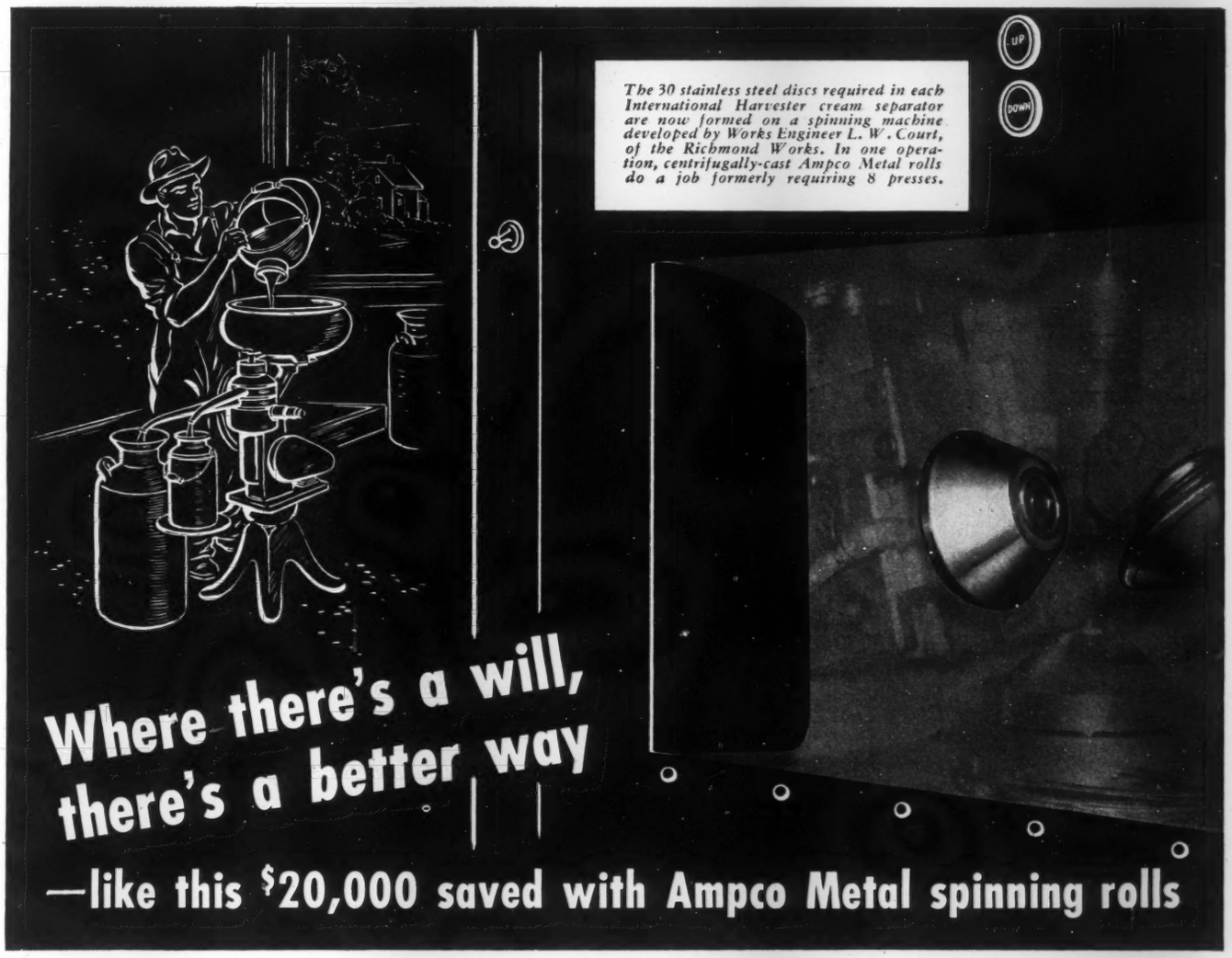
MANUFACTURERS OF B-W SUPERCHARGERS



The 30 stainless steel discs required in each International Harvester cream separator are now formed on a spinning machine developed by Works Engineer L. W. Court, of the Richmond Works. In one operation, centrifugally-cast Ampco Metal rolls do a job formerly requiring 8 presses.

Where there's a will, there's a better way

—like this $20,000 saved with Ampco Metal spinning rolls

One operation by centrifugally-cast spinning rolls replaces eight-step drawing-die process

The success of International Harvester's specially designed spinning machine depended on finding the proper metal for its rolls — a *high-strength alloy* that would spin stainless steel discs without marking them. The obvious choice — and the *right* one — was Ampco Metal, the modern aluminum bronze. A special Ampco Grade 22, centrifugally-cast, met every requirement — enabling one machine to replace a battery of 8 presses, for an annual saving of $20,000 in materials alone.

Ampco Metal is a superior aluminum bronze of closely controlled quality. It lasts several times as long as ordinary bronze alloys. Specify Ampco Metal for parts which must operate dependably under conditions of extreme wear.

Centrifugal casting, as in the spinning rolls described, provides a sound, dense structure . . . high tensile and yield strength . . . reduced machining time and scrap . . . and other advantages. Ampco Metal can also be produced by sand-casting, extrusion, or forging processes according to your requirements.

Let your nearby Ampco engineer help you select the proper grade for your needs, from the six standard grades and several modifications available. For complete information, write for Bulletin 71.

Ampco Metal has 7 outstanding performance advantages—

Excellent bearing qualities • High strength-weight ratio • High compressive strength • High impact and fatigue values • Corrosion resistance • Efficiency at extreme temperatures.

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Metal

Ampco Metal, Inc.

Department MD-5 • **Milwaukee 4, Wisconsin**

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AD-30

in selective electroplating

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Masking Troubles with

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Chemically inert, bubble-free, adhesive to all metals, Kote-Masq is a *better* stop-off lacquer in every way.

It's compounded of a high polymer, in specially selected solvents. It comes to you ready to brush on or apply by dipping. Or you can dilute Kote-Masq for spraying, if you prefer. By *any* of these methods, two coats are all you need — with only a half-hour wait between. In final air-drying or baking, too, Kote-Masq sets fast and it won't contaminate plating solutions.

Try Kote-Masq. You'll quickly appreciate its superiority as a stop-off coating in either electroplating or anodizing solutions — acid or alkaline, hot or cold! Order a trial lot now. Kote-Masq comes in 5 Gal. and 1 Gal. cans, and 55 Gal. drums.

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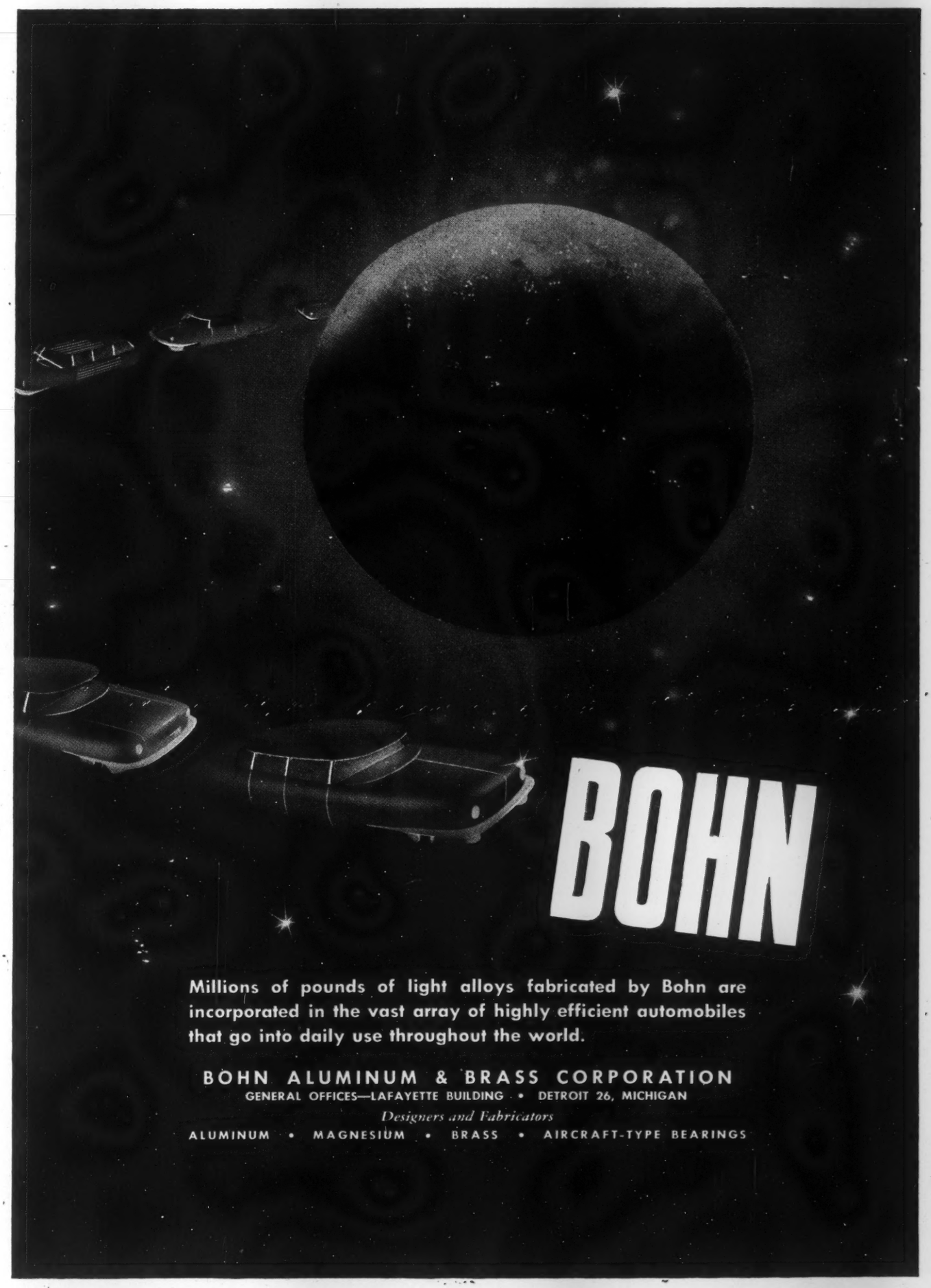

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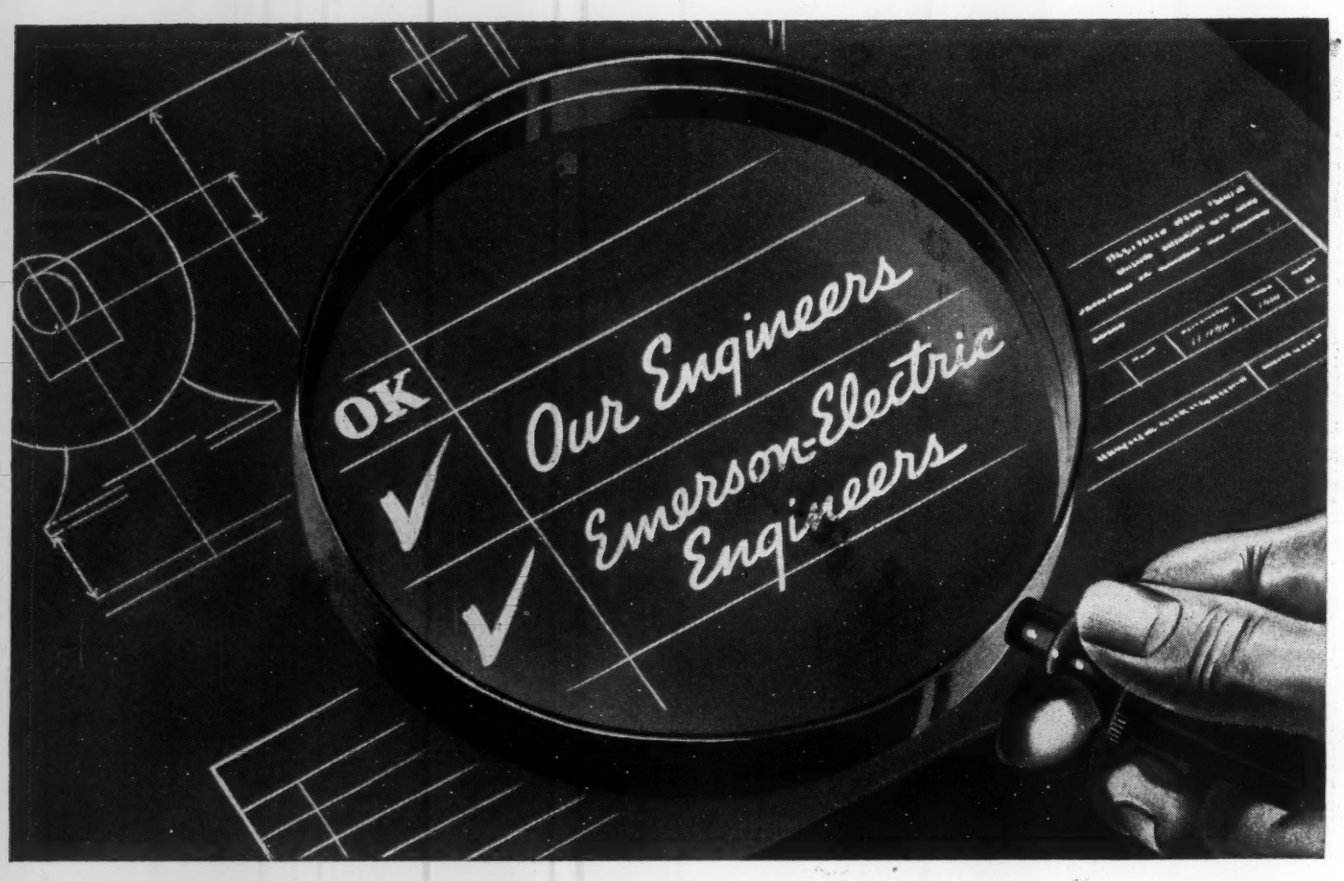
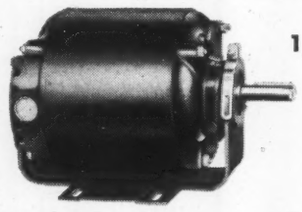


DOUBLE-CHECK your New Product Blueprints with *TWIN-GINEERING!*

WHEN the Okeh of Emerson-Electric Motor Engineers is chalked up beside your own, your new product designs are *double-checked.*

Such collaboration—*Twin-gineering,* we call it—may help you eliminate much costly engineering backtracking, may uncover manufacturing short cuts, may help you put your product on the market with competitive advantages necessary for market success.

For the present, Emerson-Electric is booked solid on motor orders. But, Emerson-Electric Engineers, backed by 56 years' experience, have never been longer on ideas and skill; and never more ready to share these advantages in suggesting money-saving motor applications for your improved or new appliances and equipment Your inquiry is invited.



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EMERSON ELECTRIC

MOTORS · FANS — APPLIANCES

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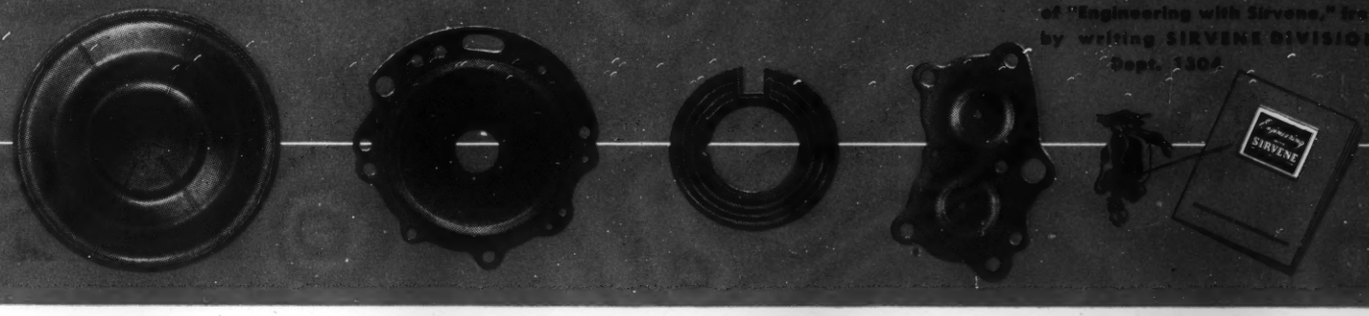
ENGINEERS, for basic information about Sirvene, you may have a copy of "Engineering with Sirvene," free, by writing SIRVENE DIVISION, Dept. 1304



Time and again Sirvene engineers serve as the hands which confirm a designer's conception. Working in Chicago Rawhide laboratories, they develop and produce the pliable parts essential to the function of his design. These unusual Sirvene parts are molded from custom-compounded formulae and verify every specification in design, elasticity or hardness, tensile strength or resilience. They are resistant to age, dryness, abrasion, wear, temperature extremes, oil, water and deterioration. When your problem involves the development of pliable parts, Sirvene offers the best solution.

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A Product of the Synthetic Rubber Division

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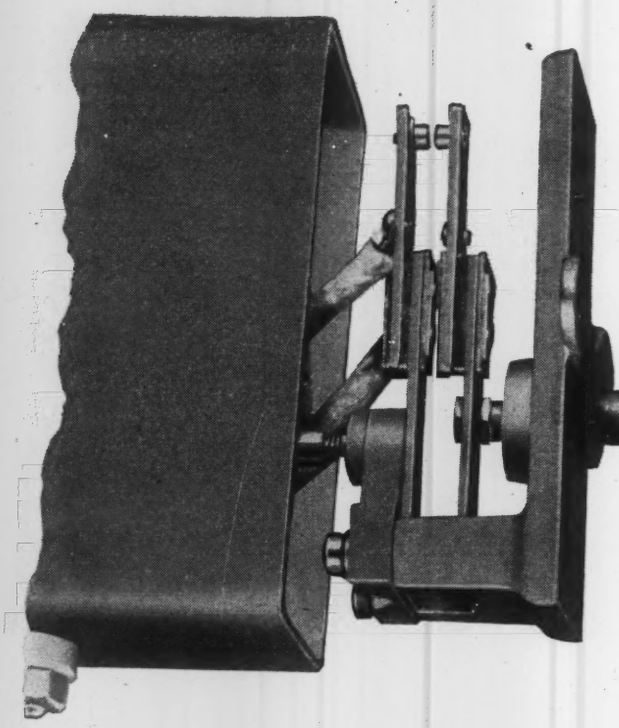


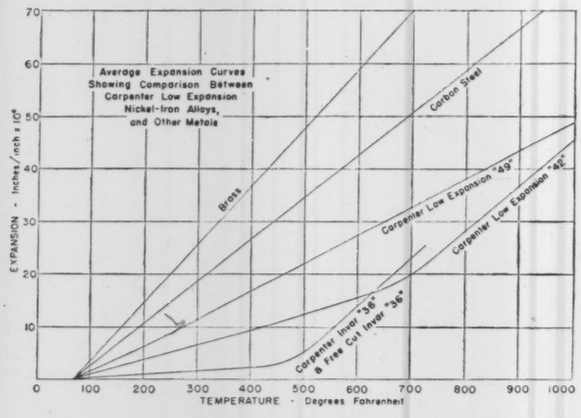
DESIGN IMPROVEMENTS

you can get with these

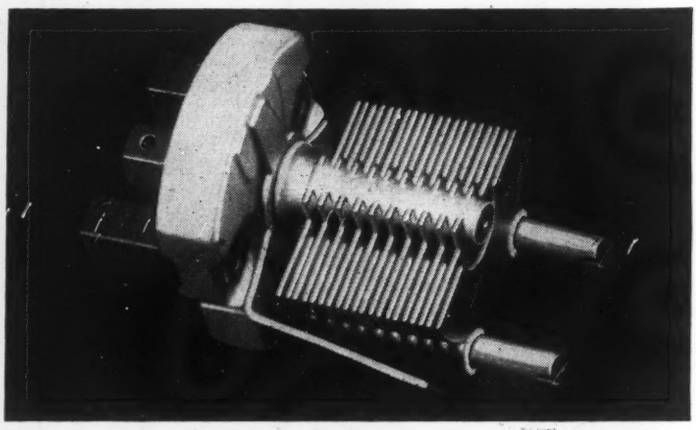
LOW THERMAL EXPANSION ALLOYS

⬅ Automatic Control Provided By Different Expansion Rates

This pencil-type thermostat makes good use of the low thermal expansion rate of Carpenter Free-Cut Invar "36". With an expansion rate about 1/10 that of carbon steel up to 400°F, this alloy provides motion due to the difference between its expansion rate and that of another metal such as brass. A rod of Carpenter Free-Cut Invar "36" is inserted into a brass tube and welded on one end. The free end of the rod is attached to a switch. The difference in expansion rates of the two metals causes movement with variations in temperature, thus actuating automatic controls.



⬅ For detailed engineering data on these alloys and the special jobs they can do for you, ask for the new Carpenter High Nickel Alloy Bulletin. It contains a complete chart showing the general effect of various percentages of nickel on the magnetic and expansion properties of iron, along with interesting application information. For your copy of the 22-page bulletin, send us a note on your company letterhead, indicating your title.



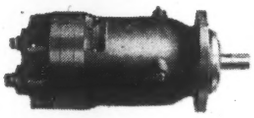
⬆ For Accurate Operation at Various Temperatures

Plates for radio condensers such as this are made from Carpenter Invar "36" in the form of strip. Because they must remain accurate and evenly spaced in hot or cold climates, the shafts and spacer bars are made from Carpenter Free-Cut Invar "36".

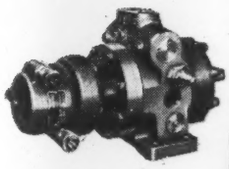
The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

Carpenter
High Nickel Alloys

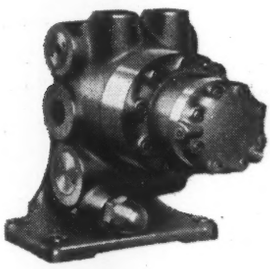
- Temperature Compensator "30"
- Carpenter Invar "36"
- Carpenter Free-Cut Invar "36"
- Glass Sealing "42"
- High Permeability "49"



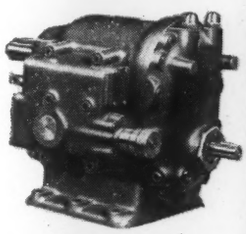
FLUID MOTORS



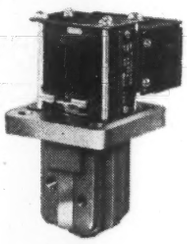
PUMPS



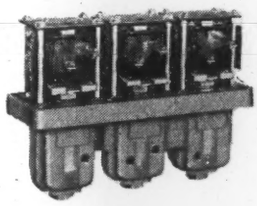
CLAMPING PUMPS



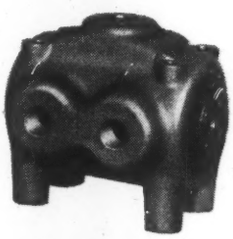
TRANSMISSIONS



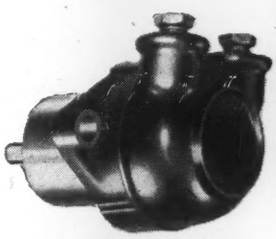
SINGLE SOLENOID VALVES



TRIPLE SOLENOID VALVES



FOUR-WAY VALVES



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AIRCO processes solve many design problems

"Designed for flame cutting and arc welding" is rapidly becoming the keynote of metal designers – everywhere. They know these processes permit a variety of special techniques that produce—economically—a lighter, stronger and better product.

If you are planning any type of metal job, whether used alone, or in combination with stampings, castings, or forgings, it will pay you to consider the many advantages of these processes:

MACHINE GAS CUTTING — permits almost unlimited freedom in cutting mild steels in the conventional manner and stainless steels by the newly introduced Flux-Injection Method. When used in conjunction with the new Airco Electronic Tracing Device it is possible to cut inside and outside square corners; obtuse and acute angles; long slim projections; narrow slots; and intricate contours.

OXYACETYLENE FLAME WELDING AND BRAZING — offers a most economical production method for "light" fabrication . . . brazing, as well as the other gas welding techniques, permit a lighter and less costly structure, possessing superior functional properties.

ELECTRIC ARC WELDING — saves time and money in "heavy" fabrication, and, with Heliwelding (today's method of arc welding stainless steel and aluminum alloys), provides maximum lightness and strength in producing modern streamlined effects.

FLAME HARDENING — permits controlled hardening of selected surfaces to specific depths to meet exacting wear resistance requirements.

Air Reduction's Technical Sales Division will help you with any design problem concerning the use of these processes. For full details address: Dept. MD-6143, Air Reduction, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas. Represented Internationally by Airco Export Corporation.

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HEADQUARTERS FOR OXYGEN, ACETYLENE AND OTHER GASES . . . CARBIDE . . . GAS WELDING AND CUTTING APPARATUS AND SUPPLIES . . . ARC WELDERS, ELECTRODES AND ACCESSORIES

*Veeder-Readings

will make for
BETTER READING
on your next Annual Report

*VEEDER READING is a standard term used by manufacturers to designate the performance figures which keep turning up on the faces of Veeder-Root Counting Devices built into—or installed on—any type of production machine or process.

These Veeder Readings are *direct* readings. Operators don't have to convert or translate them . . . which means far fewer errors. What's more, these readings indicate any mechanical slowdown, so that it can be corrected immediately . . . before final assembly bogs down, and inter-departmental timing is thrown off. These readings simplify the work of inspectors. And in many other special ways—according to the nature of the job—Veeder Readings help to save time and material, to keep costs down and output up.

That's why it pays to see to it that the new production machines you buy have this built-in Veeder-Root *Countrol*. And for the same reasons, it pays to build Veeder-Root Devices into your own machines or products. Like to see how? You can count on Veeder-Root engineers to help you, *now*. Write.

NEW! *Self-Locking Wing Nuts*

FOR DETACHABLE OR ADJUSTABLE ASSEMBLIES

FOR USE ON:
Automobiles
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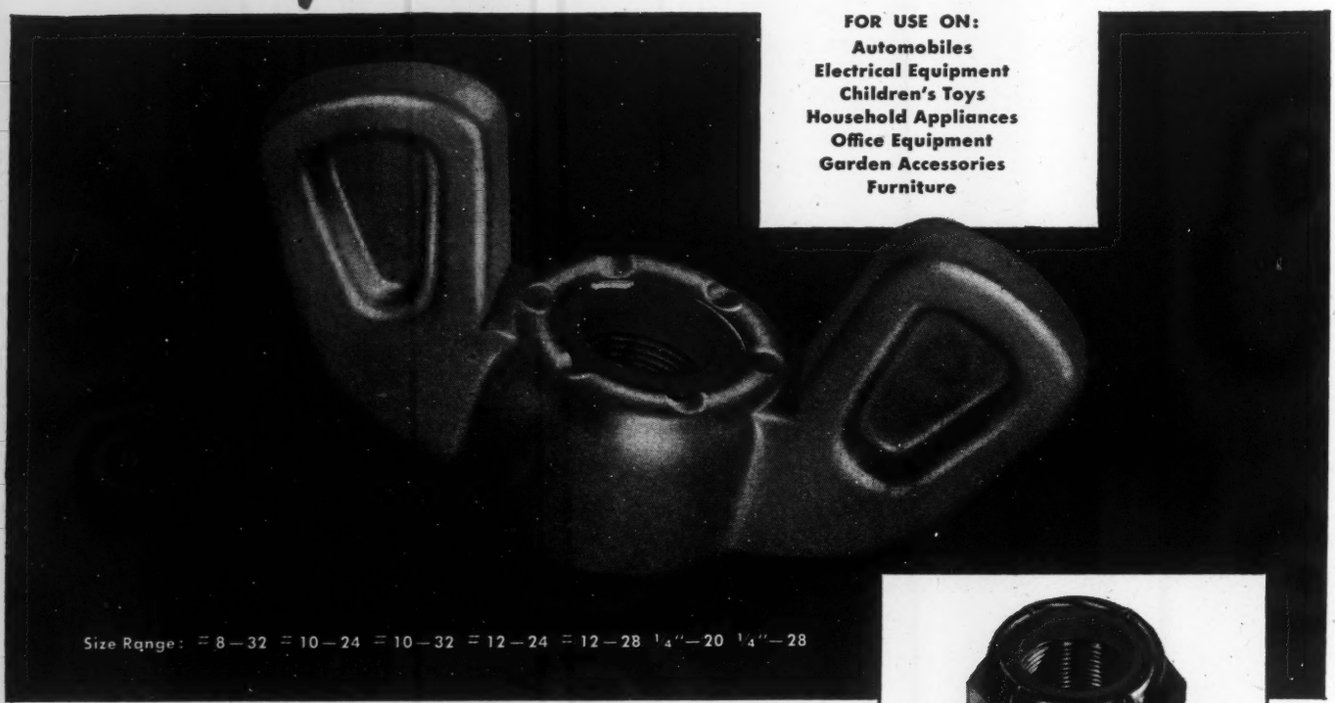
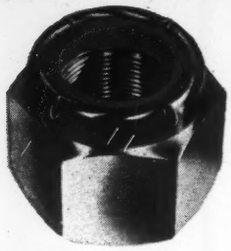


—with a Nylon Red Elastic Collar that provides dependable REUSABILITY!

Self-locking wing nuts fulfill a long-standing need. Many detachable or adjustable assemblies require the convenience of a wing nut. Yet, such assemblies have always suffered from the inability of ordinary wing nuts to stay tight. ESNA has provided the answer to this problem with a self-locking, self-sealing Wing Nut with a reusable Nylon Red Elastic Collar.

The new ESNA Wing Nuts—like all Elastic Stop Nuts—remain self-locking against Vibration, Impact and Stress Reversal in both fully seated and positioned settings. Yet, they are readily removed by hand. They do not deform the bolt, damage the threads or gall the finish.

Many opportunities exist to improve finished products and to increase their serviceability through the use of ESNA Wing Nuts. They will eliminate all wear now caused by loosened fasteners . . . permit accurate final adjustments, easy removal for quick replacements and product redesign for faster assembly. Leading industrial distributors are stocked and ready to serve you. For further information address: Elastic Stop Nut Corp. of America, Union, N. J. Sales Engineers and Distributors are located in principal cities.



LOOK FOR THE RED COLLAR
THE SYMBOL OF SECURITY

It is threadless and dependably elastic. Every bolt—*regardless of commercial tolerances*—impresses (does not cut) its full thread contact in the Red Elastic Collar to fully grip the bolt threads. In addition, this threading action properly seats the metal threads—and eliminates all axial play between the bolt and nut.

All ESNA Elastic Stop Nuts—*regardless of size or type*—lock in position anywhere on a bolt or stud. Vibration, impact or stress reversal cannot disturb prestressed or positioned settings.

ELASTIC STOP NUTS

INTERNAL WRENCHING

ANCHOR

WING

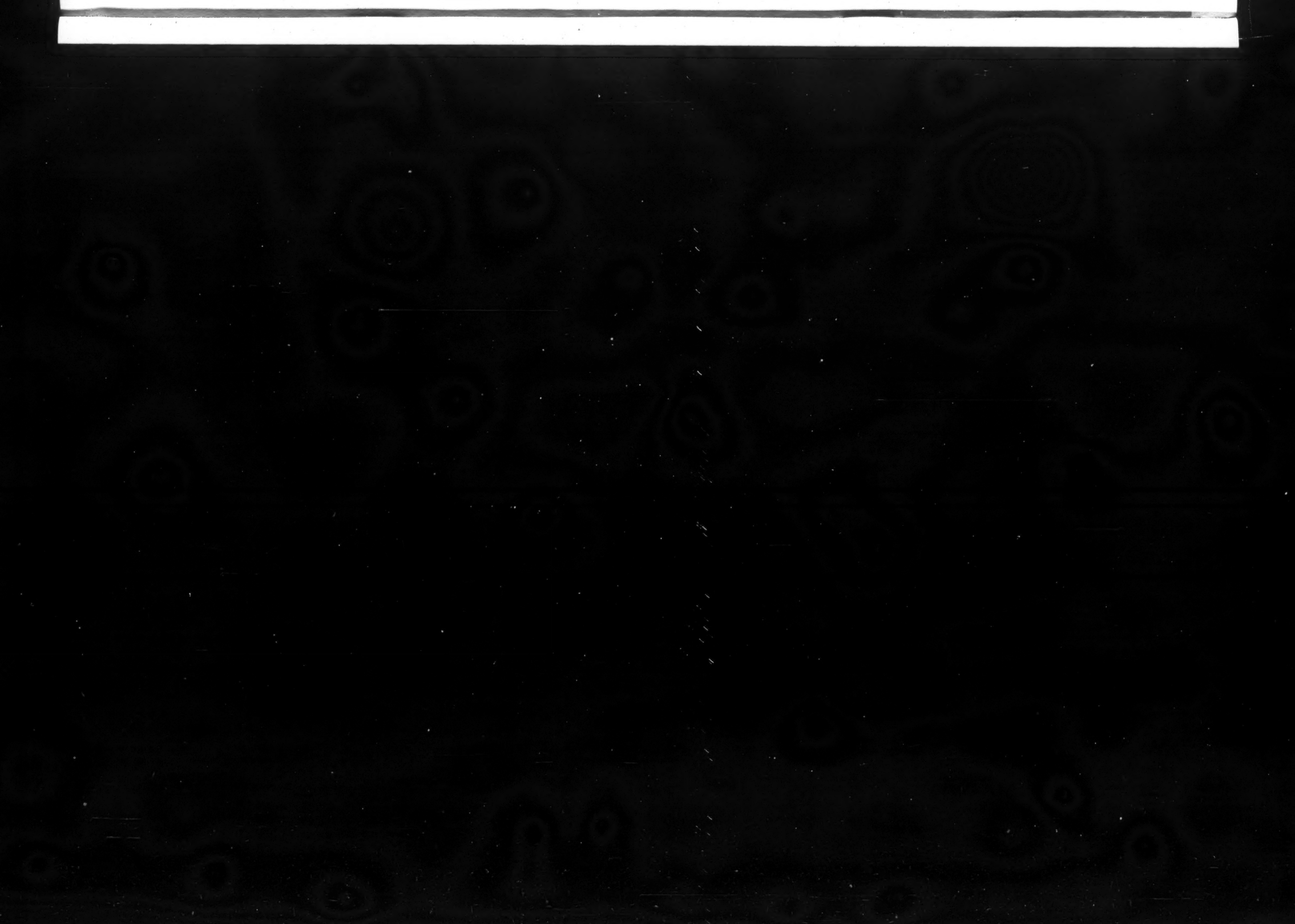
SPLINE

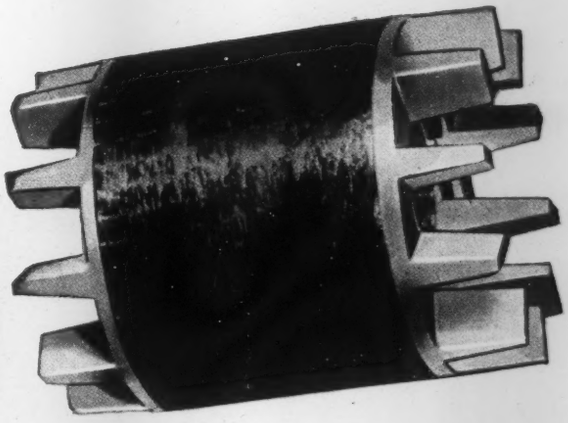
CLINCH

GANG CHANNEL

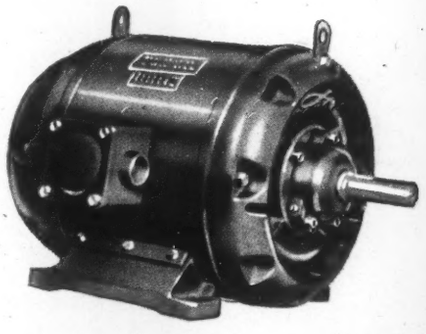
CAP

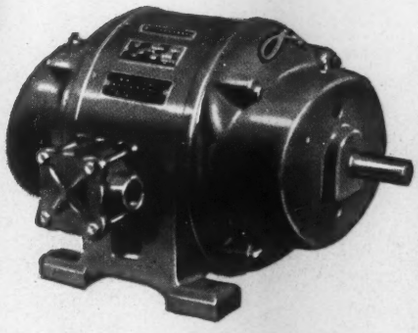
PRODUCTS OF: **ELASTIC STOP NUT CORPORATION OF AMERICA**

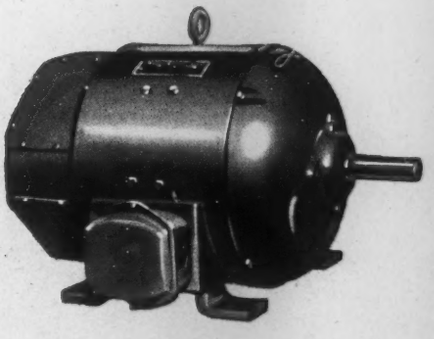




There is a size and type **LOUIS ALLIS** *electric motor for every industrial requirement.*







THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.

Our Obligation To Industry

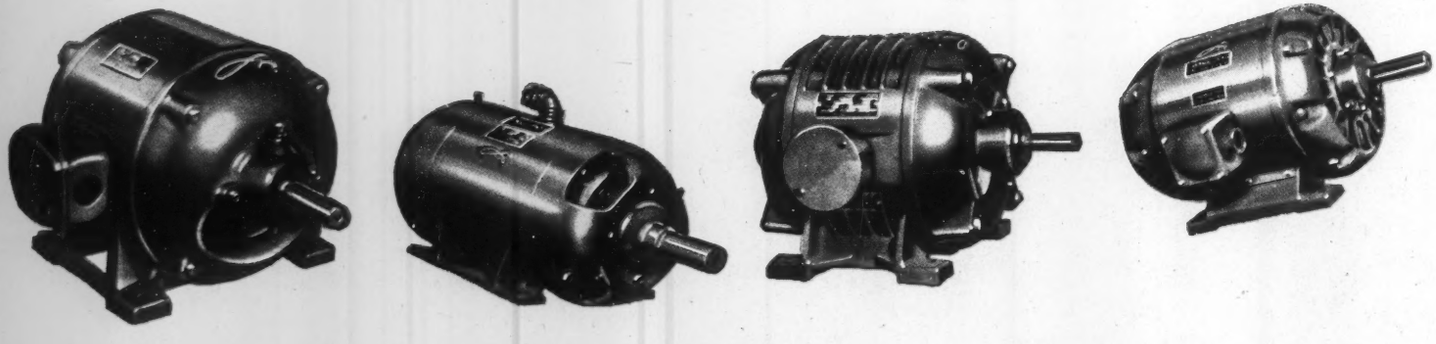
As a manufacturer of electric motors, we feel that we have a unique obligation to industry, for it is industry that creates our market for us. Our motors by themselves can't turn metal, process materials, nor drill oil wells, but properly applied to your equipment they can do all these things and many more.

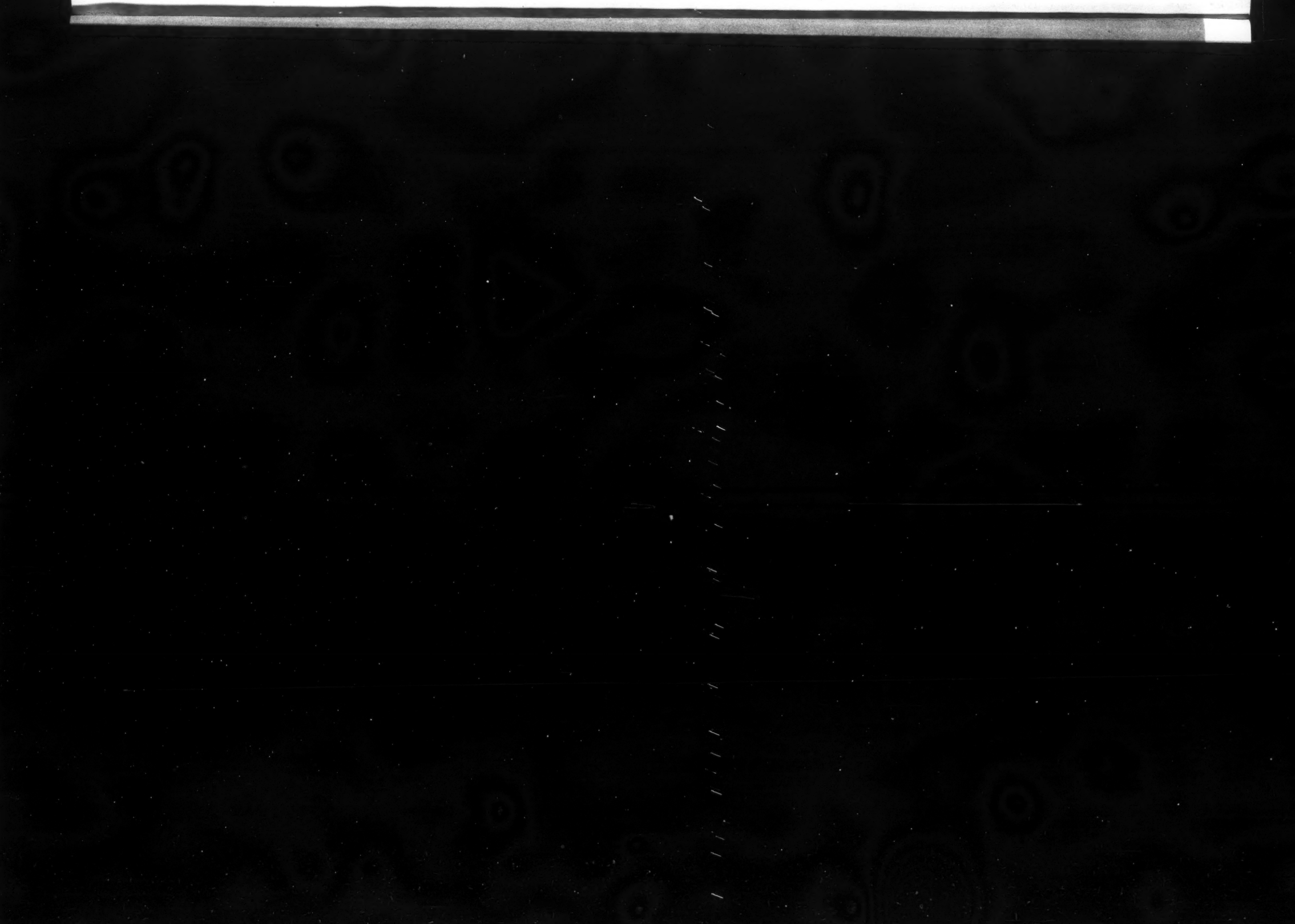
For years it has been our privilege to sit in with many of our friends on their initial discussions for designing devices to increase production. We have truly acted as their confidential electrical consultants.

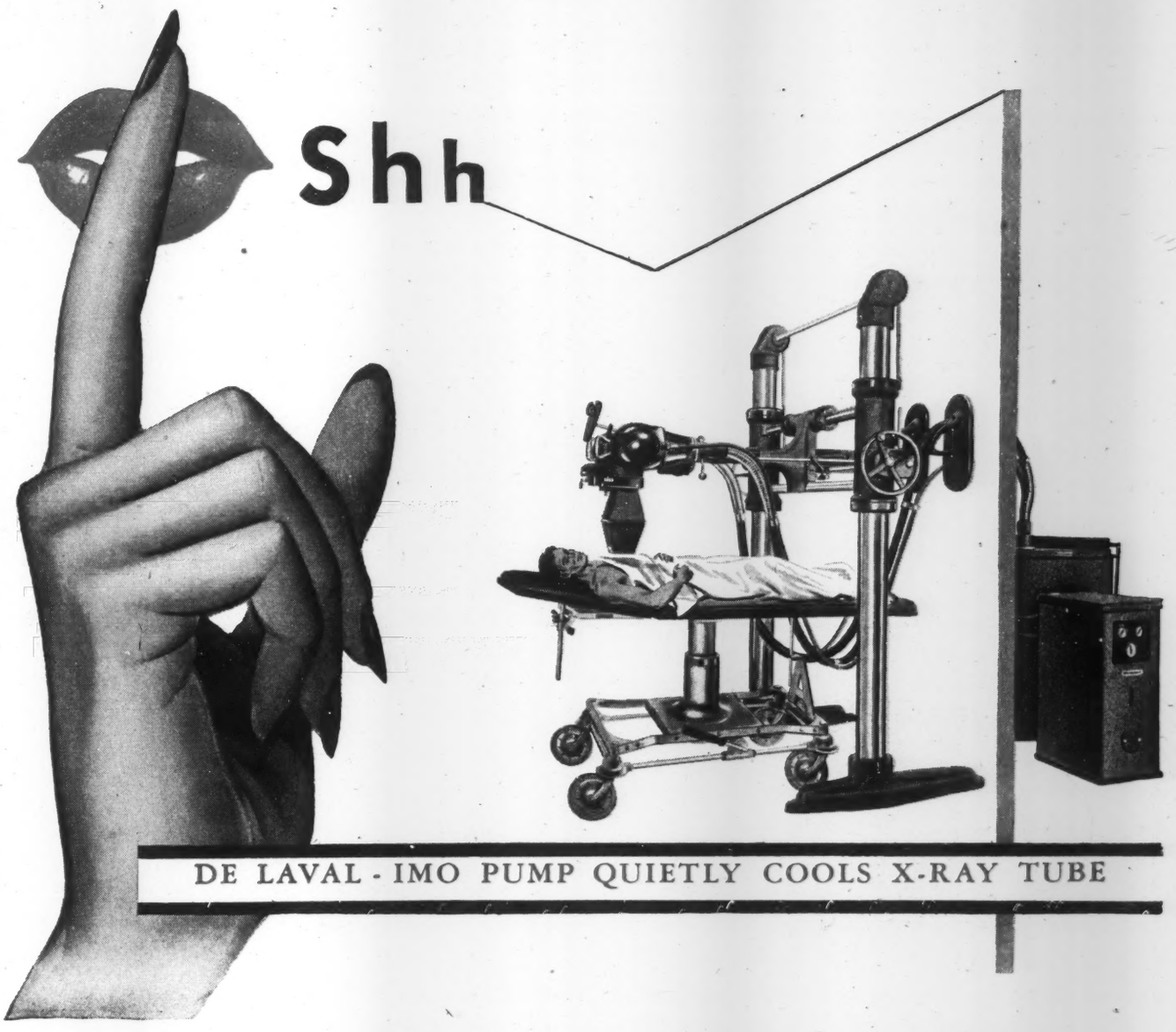
In such circumstances, our obligation is clear. We must do more than design and apply motors for maximum results at minimum cost. Above all, we must and do treat with utmost confidence the information gained through being in on the original development. At all times we must and do remember that companies who have sought our advice are developing business for us. The best interests of such customer friends are our paramount responsibility.

You can place your electric motor development problems with our engineers in complete confidence —your inquiry is invited.

THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.







DE LAVAL - IMO PUMP QUIETLY COOLS X-RAY TUBE

When designing this new deep therapy X-ray apparatus Westinghouse Electric Company engineers found that they would need a pump to circulate mineral oil to cool the tube head. Specifications called for a pump that would operate continuously for long periods of X-ray treatment, maintain a constant flow at a steady pressure and, above all, operate quietly at all times.

Many types of pumps were tested and rejected before the De Laval—IMO was found to fit the job perfectly. Of small size and high capacity, but of simple design, the De Laval—IMO pump maintains a continuous and constant flow at even pressures while operating efficiently and quietly.

This application of the De Laval—IMO pump illustrates one of the many recent IMO developments. Although we cannot predict all new developments, our experience with this new type of rotary pump enables us to offer you a complete pump engineering service.

INVESTIGATE THE IMO

IMO means I MOVE OIL

IMO Pump Division
DE LAVAL

STEAM TURBINE CO., TRENTON 2, NEW JERSEY
Manufacturers of Turbines, Gears, Pumps & Blowers

I-141-D

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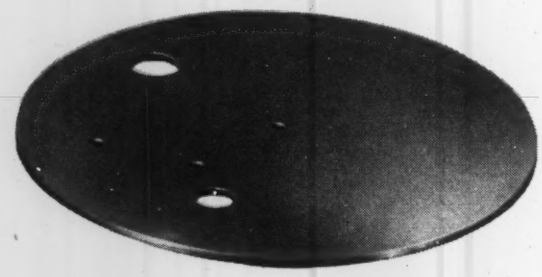
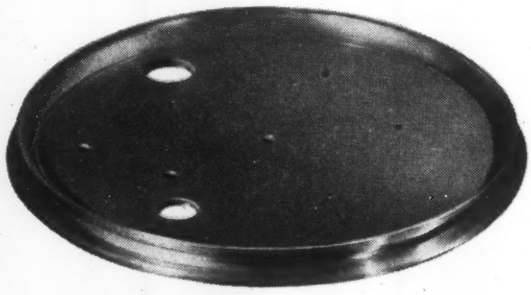
UNUSUAL METHOD OF FLANGE FORMATION



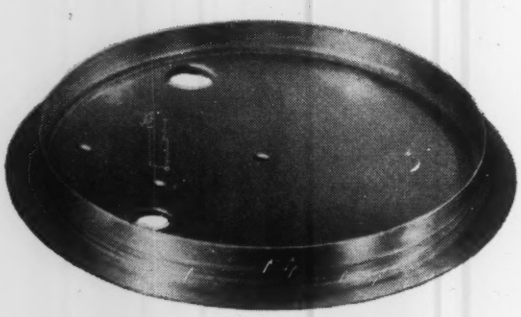
Step 1.

Discs are cut from brass squares, and holes punched for the fittings.



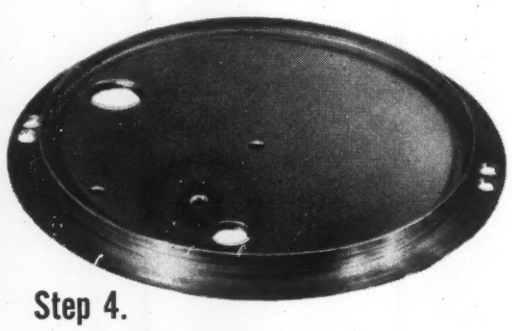
Step 2.

A slot is machined in the edge of the disc. Cutting tool is so designed that it deforms the metal on one side of the slot.



Step 3.

The deformed edge is rolled up to an angle of 90° with the disc.



Step 4.

The flange is machined down to the proper height, which automatically removes the slight puckers that appeared on the edge during the previous operation. Top is subsequently polished and nickel plated.

...A CASE HISTORY BY REVERE

THIS interesting method of producing an integral flange was originated by the Empire Milking Machine Co., West Chester, Pa. The part is a top for its milking machine pail... Revere takes pride in its collaboration on the project. The combination of cutting and deformation required special qualities in the metal; Revere recommended Cartridge Brass, Alloy No. 161, and specified the temper. The proper tool angles were worked out with the customer, and the third operation was changed from spinning to rolling. Thus rejects were reduced to practically zero, and manufacturing time and costs were lessened . . . If you have a problem in metal selection and fabrication, Revere will gladly place it in the hands of its Technical Advisory Service.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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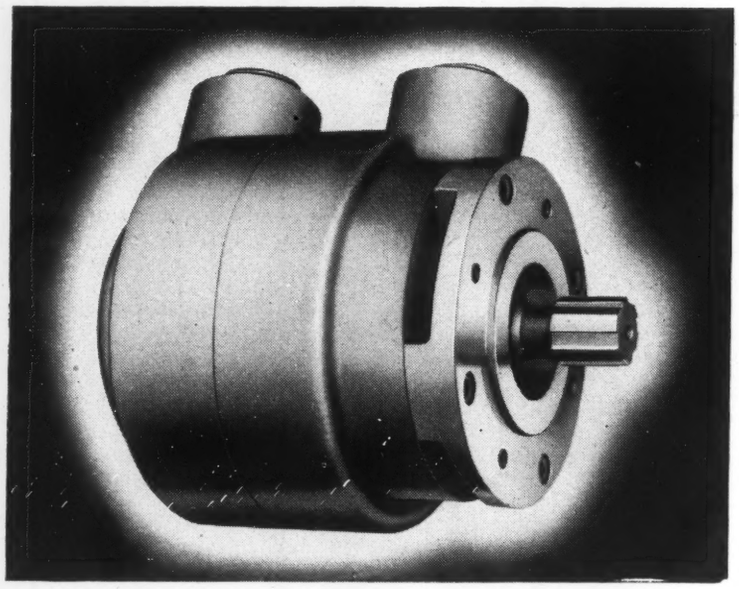
BUILT TO BE THE GREATEST VALUES IN THE FIELD

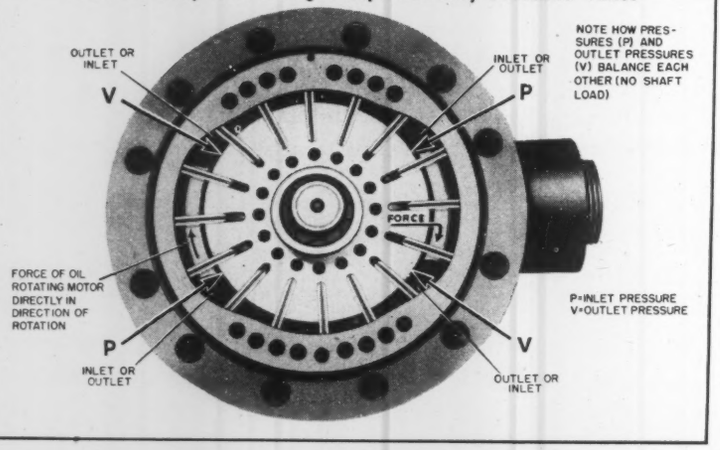
Dudco Vane-Type Fluid Motors are big news — pace setting news! Radically new and different. Operating on an exclusive design of hydraulically balanced vanes. Proven superior by comparison in five years operation on a wide variety of applications.

Smaller in size for rating, simpler in design and packed with can't-be-copied features, Dudco Vane-Type Fluid Motors are, nevertheless, the lowest in price! Model M-76,our (smallest size), 76 lb.-ins. per 100 psi is *only* **$275**

Price is the same for the 250 lb.-ins. model. Dudco motors are as small or smaller than others of similar capacity, yet sturdy enough for 1500 psi operation—an important space-saving virtue. Slow speed characteristics make possible the *elimination of transmissions*, therefore an additional saving in equipment cost. The higher torque efficiency of Dudco fluid motors makes the combination of small motor *plus* transmission no longer necessary, as the one Dudco motor takes the place of *both*, invariably *costing less than other motors alone!*



Revolutionary New Design—Hydraulically Balanced Vanes



FEATURES

- Stall torque of Dudco Motors is 90% of theoretical at all positions of shaft
- Torques range from 76 lb.-ins. to 250 lb.-ins. per 100 psi
- 3 rpm (smooth) without gear box, with torques to 1000 lb.-ins.
- Size is under 7½" diameter by 8½" long
- Mechanical efficiency (overall) 77% at 100 rpm
- 28 hp at 40 gpm, 1500 psi, 450 rpm
- Maintenance problems can be handled by any good shop mechanic
- Adaptable to applications requiring revolving nut or automatic declutching of shaft from motor
- Hydraulically balanced—no cams or wear plates to transmit longitudinal motion to radial motion

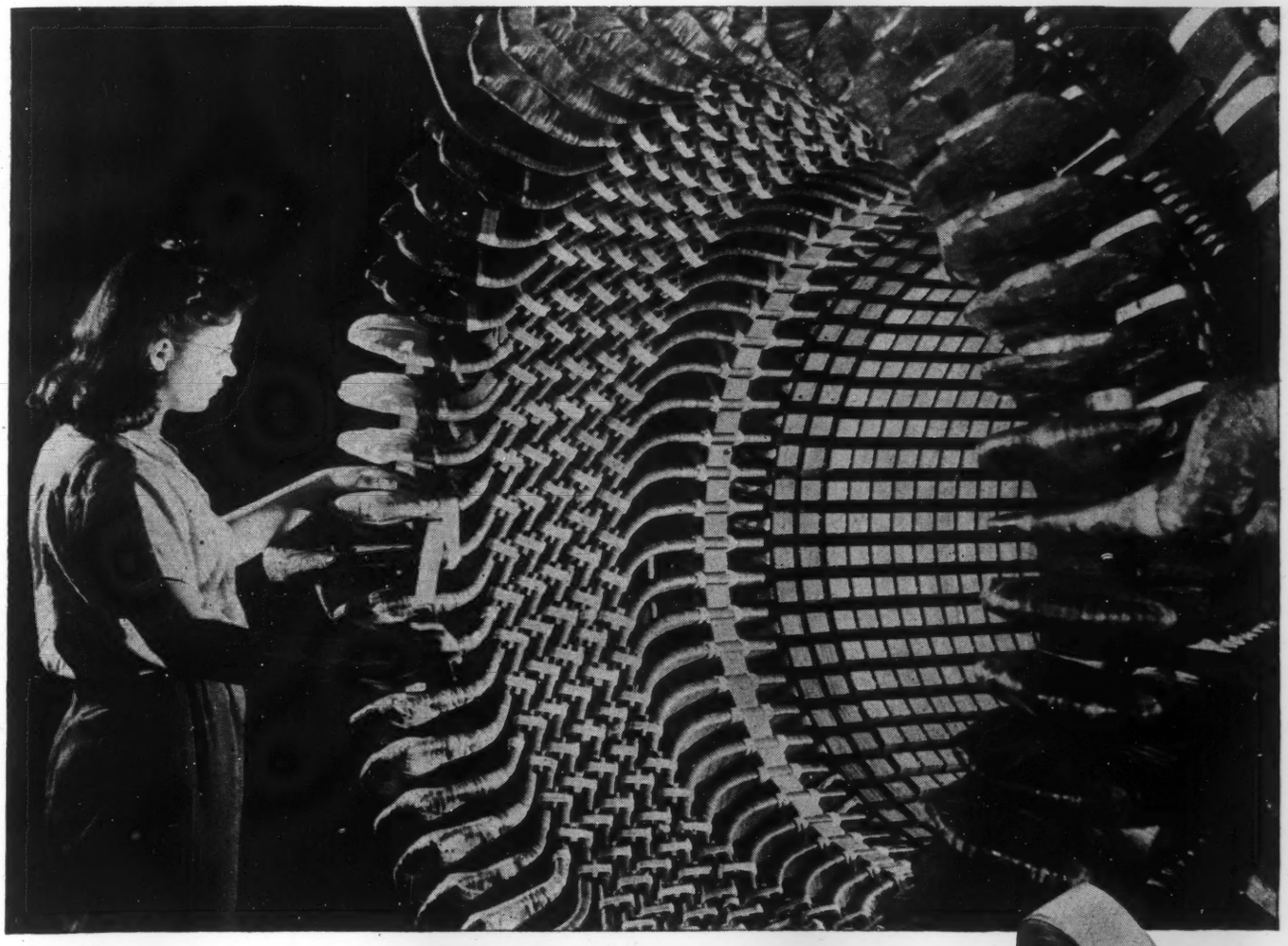
Write for Details

Descriptive folder and data sheets are available. Also write about your specific needs. Our engineering department will gladly assist with your problems.

DUDCO PRODUCTS COMPANY

Formerly DETROIT UNIVERSAL DUPLICATOR CO.

18100 RYAN ROAD • DETROIT 12, MICHIGAN



10 MILES OF FIBERGLAS TAPE— on 43,750 kva. turbo-generator

This turbo-generator, being built by the Westinghouse Electric Corporation, is capable of supplying enough power to take care of the electrical requirements of a community of approximately 35,000 persons.

About 10 miles of Fiberglas tape was used to insulate the end connections of the armature. Here is an application that is typical of many in which Fiberglas-base insulating materials provide a margin of safety in many types of electrical equipment.

Fiberglas-base insulating materials have a high resistance to moisture, corrosive acids and vapors and the effects of overloads. They will withstand heat far beyond the temperature range of even the newer insulating varnishes. Therefore, should the impregnants burn out, the Fiberglas base still provides protection as a permanent spacer.

Fiberglas Electrical Insulating Materials are available in forms to meet practically every insulation need. If you are concerned with the design, manufacture, use or maintenance of electrical equipment, get all the facts about Fiberglas Electrical Insulations. Write for catalog EL46-11—Owens-Corning Fiberglas Corporation, Dept. 808, Toledo 1, Ohio. Branches in principal cities.

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ELECTRICAL INSULATING MATERIALS

TAPES • CLOTHS • BRAIDED SLEEVING • VARNISHED TUBING • MICA COMBINATIONS • LAMINATES

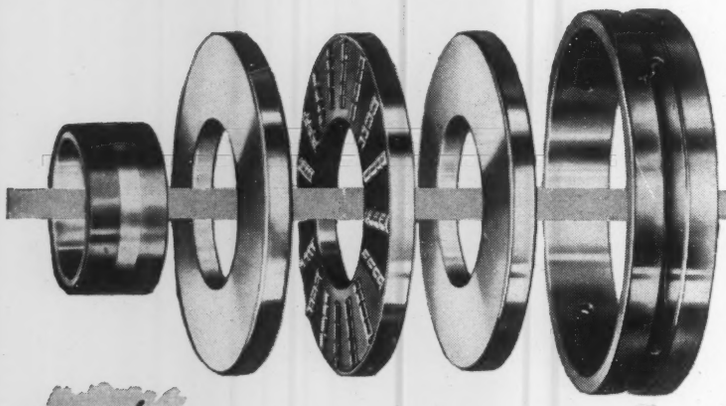
SPLIT YOUR LOAD IN TWO !

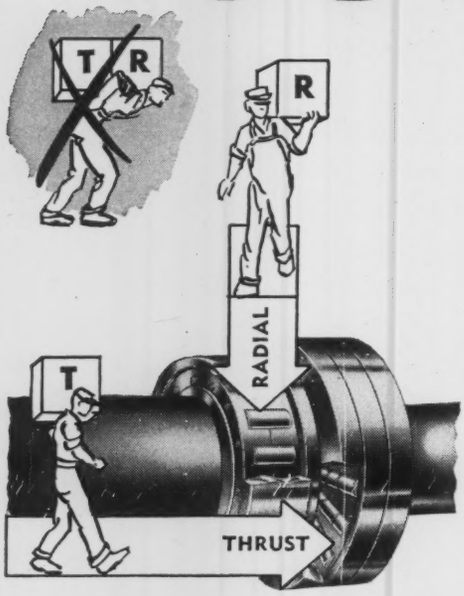
with

ROLLWAY

RIGHT-ANGLE-LOADED

BEARINGS

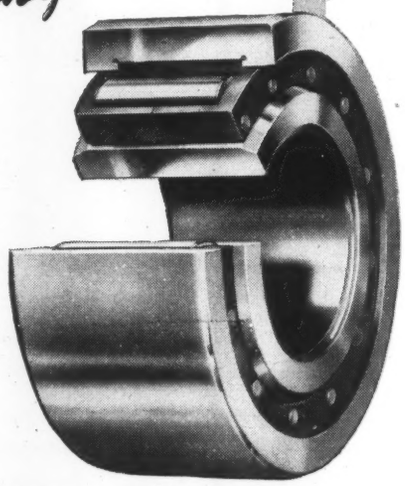




Right-Angle Loading splits compound loads into the two component parts of pure radial and pure thrust... and carries each of these components on separate bearing assemblies. **Simple but scientifically sound.**

1. **Keeps bearings free of complicated stresses**
2. **Gives longer bearing life with higher capacity**
3. **Cuts maintenance cost and lay-up time**

What Right-Angle-Loading Does!



1. Prevents wedging of rollers and pinch-out. Reduces roller end-rub, with its wearing friction. Holds starting and operating torque at a minimum.
2. Since only pure radial or pure thrust loads can be imposed upon any single bearing assembly, unit pressures are reduced substantially.
3. Since all loads are carried at right-angles to the roller surface, compound or oblique loads are avoided and so are the resultants of the oblique loads.
4. Right-angle loading permits greater radial or thrust load-carrying capacity in any given dimension.
5. Right-angle loading assures solid cylindrical rollers of greater roller mass and uniform roller cross-section . . . greater resistance to shock loads and vibration . . . longer life expectancy under continuous heavy-duty service.

Free Service!

Select the RIGHT bearings for YOUR particular needs . . .

Rollway engineers will gladly make necessary calculations, drawings and supply other required information for a complete understanding of your bearing problem. *No charge.*

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ROLLWAY BEARING COMPANY, INC., SYRACUSE, N. Y.

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Improved sea water pump uses neoprene impellers

THIS TOUGH, DURABLE NEOPRENE IMPELLER MINIMIZES WEAR CAUSED BY SAND AND SILT

Illustration courtesy of Gray Marine Motor Company

IMPELLERS in a sea water pump are often subjected to extreme abrasive action from water-borne sand and silt. Conventional metal pumping gears wear out quickly in such service. To overcome this, a resourceful manufacturer replaced metal pumping gears with impellers made of neoprene. Now the results of cutting and abrasion are minimized. The tough, durable neoprene impellers seldom need replacement . . . they resist deterioration from grease and oils, retain their resilience, and have low permanent distortion.

When you need a rubber for tough service, specify neoprene. We'll be glad to furnish technical information, work with your supplier, or help you find a source for finished neoprene products.

. . .

Write today for your free subscription to The Neoprene Notebook. Here are stories about the design problems of others, and how neoprene furnished the solution. You may find valuable ideas.

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HERE'S WHY NEOPRENE DOES SO MANY JOBS SO WELL!

- ★ High tensile strength, resilience, low permanent distortion.
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- ★ Superior resistance to sunlight, aging, ozone, and heat.
- ★ Resistance to deterioration by oils, solvents, chemicals, acids.
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- ★ Special compositions are flame-retarding, static-conducting, flexible at low temperatures.

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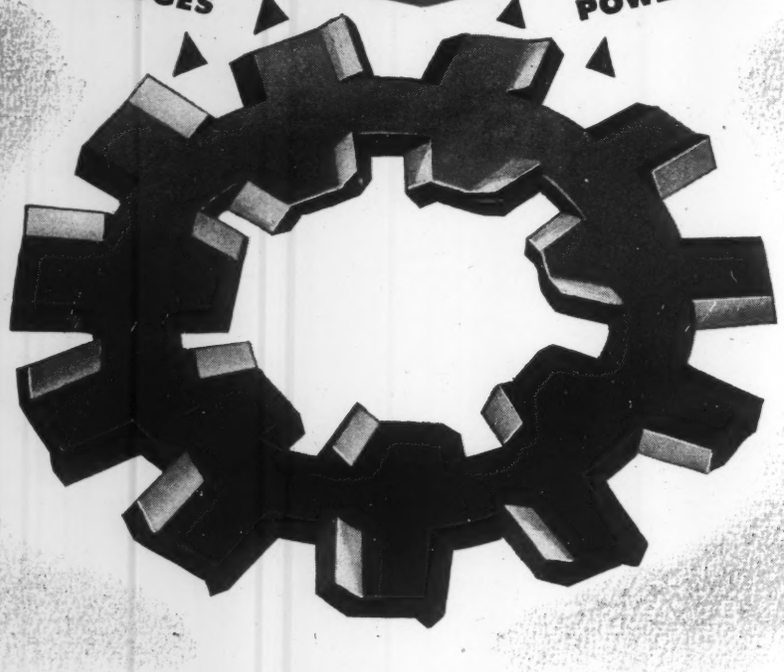
THE WASHER THAT HAS THE EDGE

Ever LOCK WASHERS

MANY WIDE CHISEL EDGES

POWERFUL SPRING TENSION



The effectiveness of EverLOCK *double* gripping action—wide chisel edges teamed up with balanced spring tension—make EverLOCK Washers first choice wherever *positive* locking action is vital.

EverLOCK Washers are equally outstanding in holding down production costs. A half turn or less gives a positive lock—saving time and labor—avoiding all hazards of stretched bolts and distortion of threaded parts. Four standard types meet most lock washer needs.

Your inquiries are invited.

THOMPSON-BREMER & CO., 1636 W. HUBBARD ST., CHICAGO 22, ILL.

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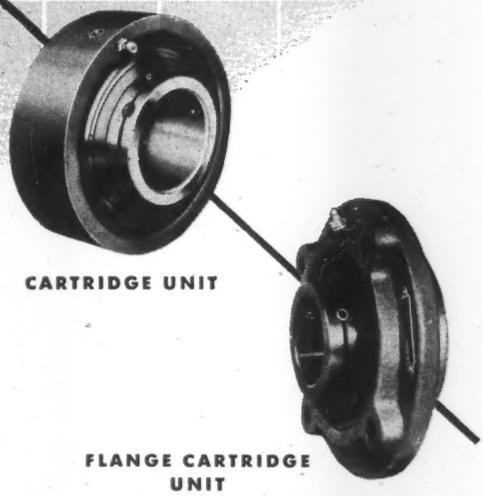
SEALMASTER

BALL BEARING UNITS

PILLOW BLOCK

FLANGE UNIT



CARTRIDGE UNIT

FLANGE CARTRIDGE UNIT

"Only SealMasters Have *All* the Essential Features"

This *exclusive combination* of SealMaster advantages assures smooth, quiet operation and bearing satisfaction in all types of machinery and equipment—new or redesigned. Dependable SealMasters—permanently sealed and self-aligning—built to take both radial and thrust loads—furnished in several types of housings.

SELF-ALIGNING—The bearing assembly is self-aligning in the housing. Shaft misalignment cannot distort the seal.

PERMANENTLY-SEALED—SealMaster's patented centrifugal seal retains the lubricant and excludes dirt and dust.

PATENTED LOCKING PIN—Eliminates housing wear and noise by preventing rotation of the outer race. Positions unit for relubrication.

PRE-LUBRICATED—All SealMasters are shipped with lubricant sealed in—ready for immediate use.

Catalog No. 845 gives sizes, dimensions and complete engineering data.

BEARING DIVISION

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A SOUND REASON

What do you buy in a casting?

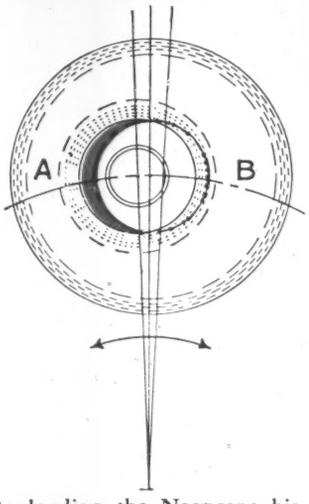
Just so many pounds of metal at so much a pound? We think not. We think you buy better, stronger, longer-wearing parts—by buying *sound* castings, free from internal flaws or voids. You buy castings produced to close dimensions, without surface blemishes—so you'll have lower machining costs.

That's why we think you'll want to buy Dodge Steel Castings. For years we've been operating on the principle of making sound castings in the mold. The proof of how well we've lived up to that principle is evidenced in our record of rejects, almost zero—the lowest in the industry, to the best of our knowledge. Proof, too—and the only way we can continue to stay in business profitably—is our record of repeat business from satisfied customers. We're anxious to count you in that ever-growing group. May we talk it over?

DS

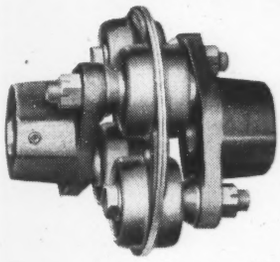
DODGE STEEL CASTINGS

DODGE STEEL COMPANY • TACONY, PHILADELPHIA 35, PA.



Pre-loading the Neoprene biscuits in assembly enables them to distribute uniform stress throughout their volume. Torque loads and torsional vibration cause torsional deflection, increasing pressure at side A and reducing pressure at side B. Under maximum pressure, however, the Neoprene at side B is still loaded.

MORFLEX COUPLINGS are SOFT (Resilient)



Special Neoprene biscuits cushion shock loads and isolate vibration. Morflex protects both the driving and driven units from the impact of uneven impulses, also compensates for misalignment of shafts. Our engineers are available for consultation on applications.

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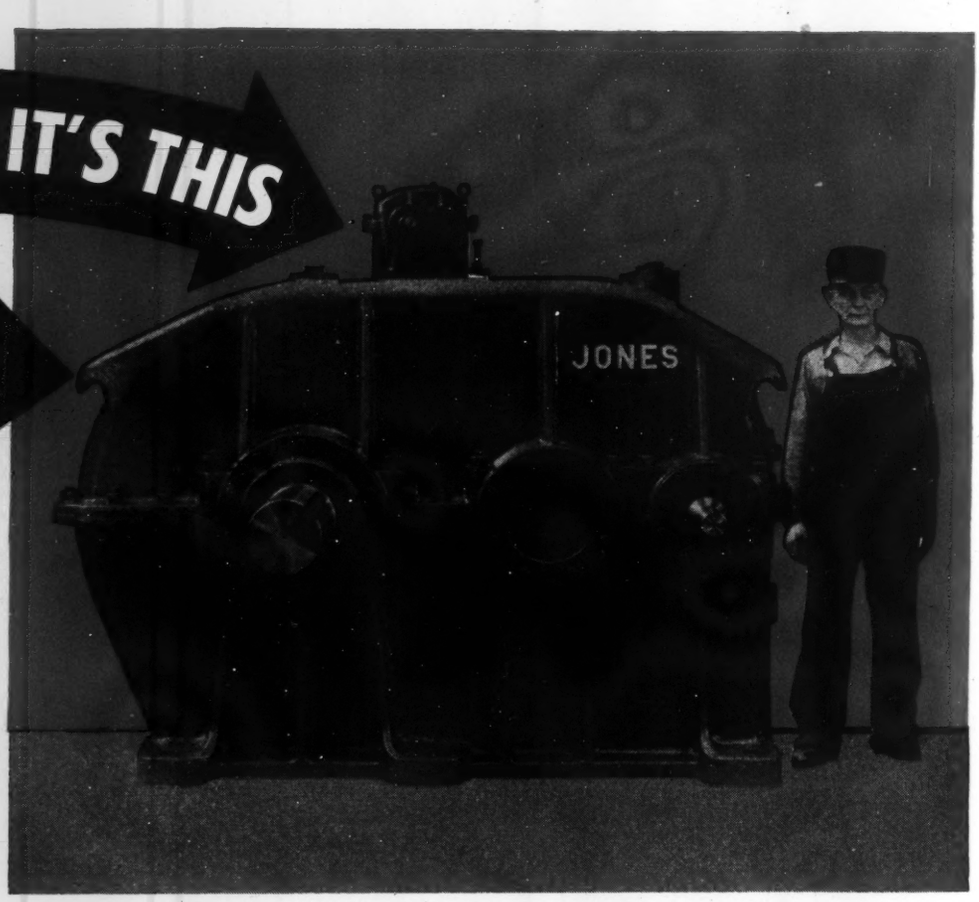
MORSE

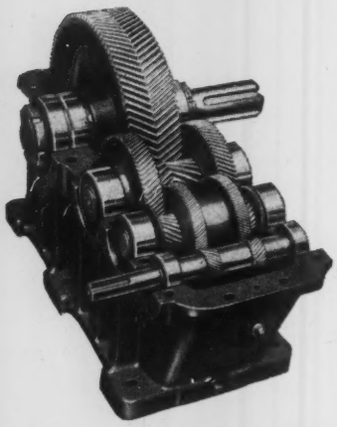
MECHANICAL POWER TRANSMISSION PRODUCTS

WHETHER IT'S THIS

—OR THIS



. . . both are designed and constructed to give satisfactory service and long life



The above view of a Jones Triple Reduction Herringbone Speed Reducer is typical of a line that is noted for advanced design, superior materials, precision workmanship.

TWENTY FOUR hours a day operation plus loading up to rated capacity or beyond are testing speed reducers in every type of service.

Jones Herringbone Speed Reducers are establishing remarkable service records under these conditions. One reason of course is the fact that Jones Reducers have always been rated in accordance with the recommended practice of the American Gear Manufacturers Association.

With this conservative rating policy goes sturdiness, compactness, symmetry and balance—all factors that influence maximum efficiency, long life and improved performance.

Jones Herringbone Gear Speed Reducers are built in a wide range of ratios and ratings to cover every requirement. Single (Type SH) reducers in standard ratios range from 1.25 to 1 up to 11 to 1 in ratings from 1.3 to 440 H.P. Double (Type DH) reducers are built in standard ratios from 10.9 to 1 up to 72 to 1 in ratings from 0.5 to 275 H.P. The triple reduction reducers (Type TH) cover a range of ratios from 86.9 to 1 up to 355.8 to 1 in ratings from 0.3 to 78 H.P.

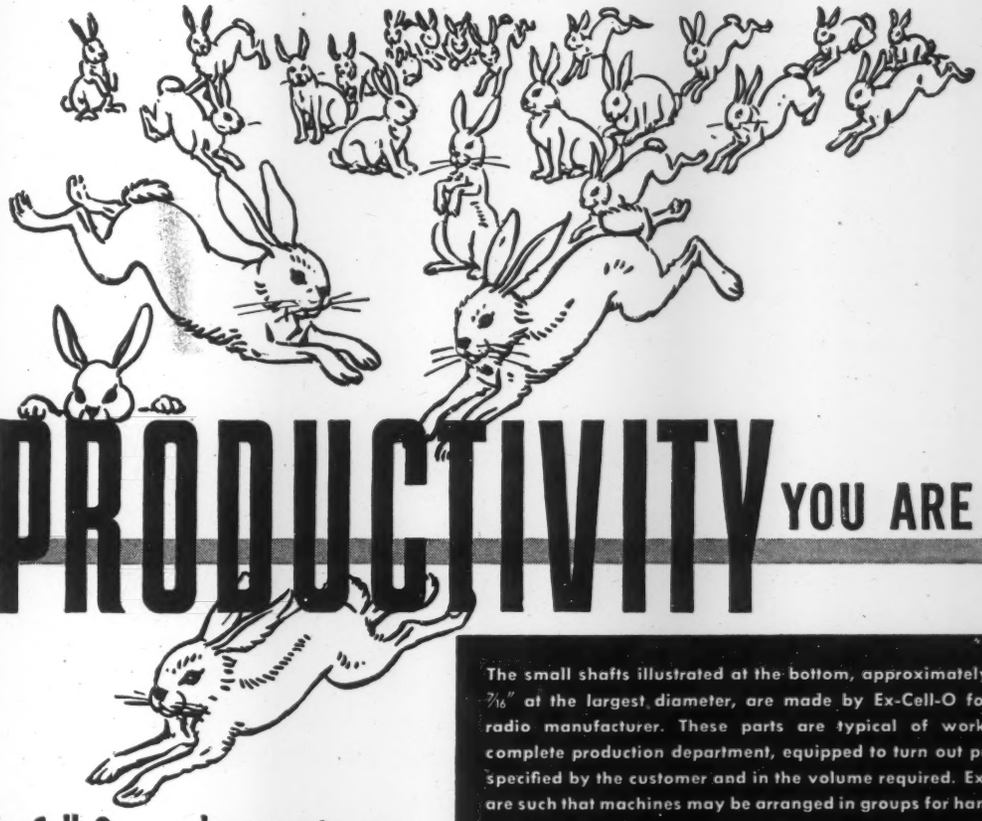
All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Cast iron bases are available for all variations of motor assembly.

For complete information on both standard and special applications of Jones Herringbone Reducers ask for Catalog No. 70. This 128 page catalog is a comprehensive technical treatise on the whole subject of Herringbone Reducer application for all conditions of service. If you have any type of drive problem that might call for Herringbone gears we shall be pleased to send you a copy.

W. A. JONES FOUNDRY & MACHINE CO., 4413 Roosevelt Road, Chicago 24, Ill.

Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • PULLEYS • GEARS • V-BELT SHEAVES • ANTI-FRICTION PILLOW BLOCKS • FRICTION CLUTCHES • FLEXIBLE COUPLINGS



IF IT'S PRODUCTIVITY YOU ARE AFTER

Consider Ex-Cell-O . . . where parts production is keyed to *your* exact requirements

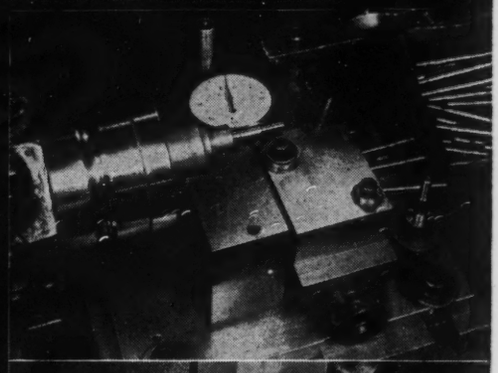
The long years of engineering experience . . . the modern and complete facilities . . . the manufacturing "know how" . . . that have made Ex-Cell-O an outstanding name in the metal-working industry . . can help you solve your problem if you are in need of accurate parts and sub-assemblies for your product, whether old or new. Ex-Cell-O, *with machining, heat-treating, grinding and sub-assembling facilities all under one management,* offers you many practical advantages. Send your print or part to Ex-Cell-O in Detroit today, or get in touch with any member of Ex-Cell-O's field engineering staff in thirty-two leading industrial centers in the United States and Canada.

XLO
EX-CELL-O for PRECISION

Modern machine tools mean "*more goods for more people at lower prices*" . . . see 1947 Machine Tool Show in Chicago in September!

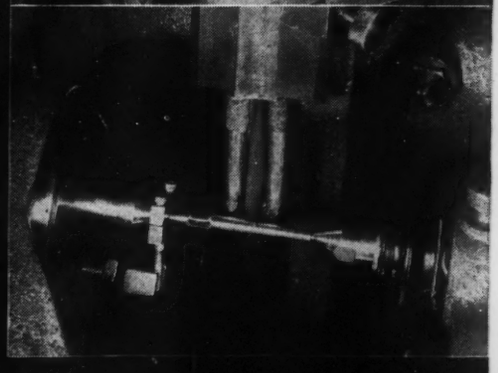
The small shafts illustrated at the bottom, approximately 3½" long and 7/16" at the largest diameter, are made by Ex-Cell-O for a well-known radio manufacturer. These parts are typical of work in Ex-Cell-O's complete production department, equipped to turn out parts to the limits specified by the customer and in the volume required. Ex-Cell-O facilities are such that machines may be arranged in groups for handling successive operations in the most efficient and economical manner.

★



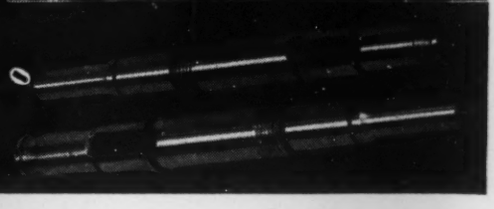
To right: Grooving radio shafts on Ex-Cell-O Precision Boring Machine. Widths of grooves are held within .004" and distance between grooves is held within .005".

★



To right: On an Ex-Cell-O Style 33 Precision Thread Grinder a 3/8-20 thread is ground on the parts after they have been hardened.

★



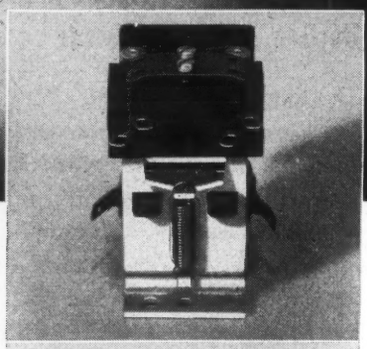
To right: Hardened and ground precision radio shafts, referred to above, made in Ex-Cell-O's Parts Production Department.

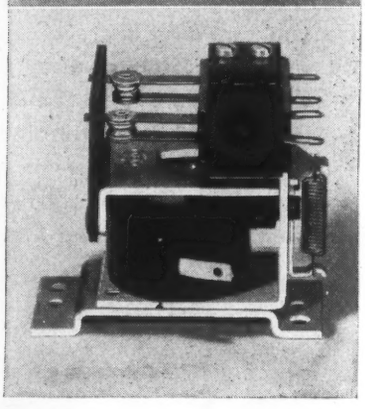
47—3

EX-CELL-O CORPORATION DETROIT 6 MICHIGAN

MANUFACTURERS OF PRECISION MACHINE TOOLS AND CUTTING TOOLS • PRODUCTION PARTS AND SUB-ASSEMBLIES

VERSATILE NEW LINE OF... A·C AND D·C RELAYS





EXCEPTIONALLY SMALL AND COMPACT YET EXTREMELY RUGGED!

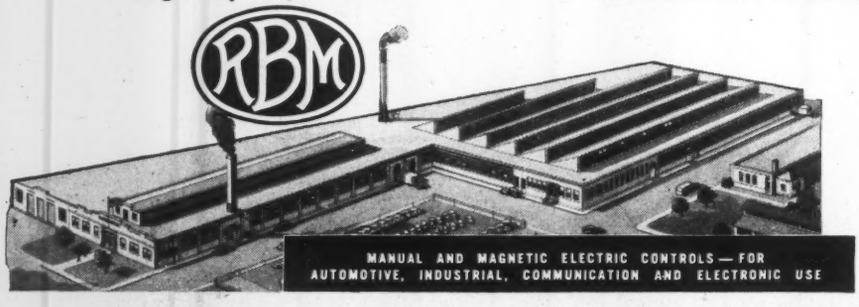
● R-B-M announces a new line of general purpose magnetic relays, with either A.C. or D.C. shunt coils or series coils, for electronic applications.

Relays are available in standard contact arrangement of single and two pole normally open, normally closed; or double throw with light and heavy contacts. Four and six pole double throw relays are available with 3 ampere contacts at 32 volts or less.

Insert shows double pole, normally open contactor rated 13 amperes, 115 volts, A.C., and 6.5 amperes at 230 volts, A.C. This relay is designed in accordance with Underwriters' specifications and will ultimately carry Underwriters' Approval for Small Devices classification.

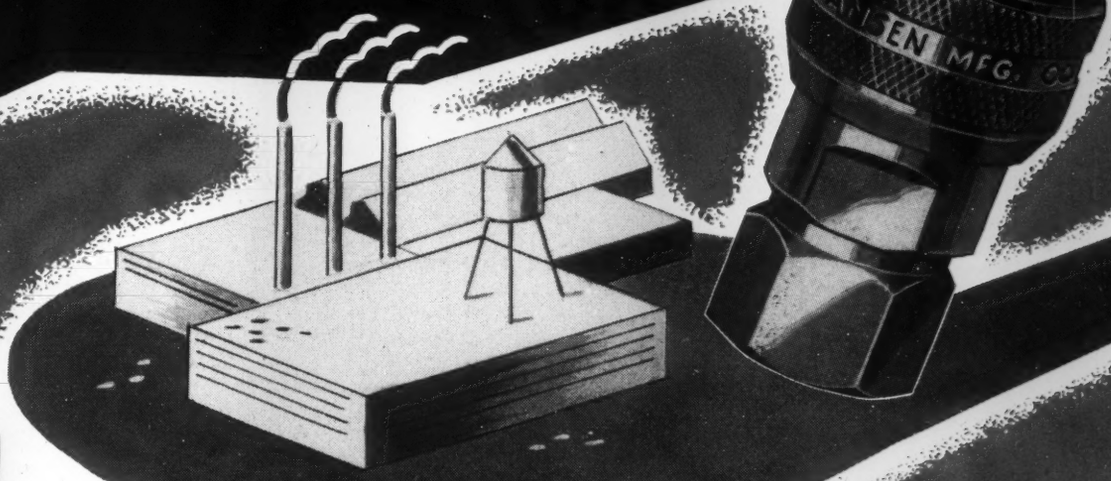
For further information write for Bulletin 570. Address Department **H-5**

R-B-M DIVISION
ESSEX WIRE CORPORATION
Logansport, Indiana



WITH AN EYE ON PRODUCTION *Costs*

AND PRODUCTION *Volume*



AIR, OIL-GREASE COUPLING

OXYGEN COUPLING

HANSEN COUPLINGS

SAVE TIME...CUT COSTS

It's the minutes saved on operations repeated many times daily that mount up to substantial savings in time...and money. With Hansen Couplings, connections and change-overs become a matter of seconds with no hold-up of costly operations.

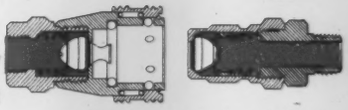
To connect a Hansen coupling, you merely push plug into socket. To disconnect, slide sleeve back with thumb. In both cases, flow is immediately and automatically turned on or off . . . with no time wasted, no losses.

There is a specific Hansen coupling, made for air, oil or grease, for oxygen, and for acetylene. Available in a wide range of standard sizes.

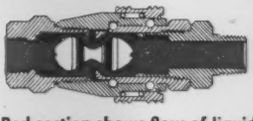
Write for catalog describing full line of Hansen couplings and fittings for industrial use.

ACETYLENE COUPLING

The Hansen Two-Way, Shut-Off Coupling.



Red section shows how rubber washer in valve stem contacts valve seat in both plug and socket, sealing both plug and socket against leakage instantly.



Red section shows flow of liquid or gas around spool section of valve, permitting free flow of liquid or gas through coupling instantly upon connection.

REPRESENTATIVES

New England States:
A. D. GEIGER, Belmont, Mass.

Eastern, Southern States:
B-R ENGRG. CO., Baltimore, Md.

Northern Ohio:
F. & W. URSEM CO., Cleveland, O.

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THE HANSEN MANUFACTURING CO.

1786 EAST 27th STREET • CLEVELAND 14, OHIO

TAKE A PEEK at FERRY CAP *Quality*

HERE'S a place where quality really pays dividends. Because quality is so important, many engine and other manufacturers have enhanced the value of their assemblies with Shinyland studs

Shinylands of the usual Ferry Cap high quality are furnished to regular milled stud standards with this additional feature—the land between threads a shiny, bright mirror-finish.

Shinylands are carried in stock in standard catalog sizes in bulk and in attractively labeled packages; sizes, ¾" dia. and under.

See this achievement in Ferry Cap stud production. Send for samples of Shinylands.

When ordering from your distributor insist upon Shinylands.

Simply Specify

SHINYLANDS for studs with land between threads, shiny, bright mirror-finish.

SHINYTHREADS for studs with aircraft quality, bright, shiny threads.

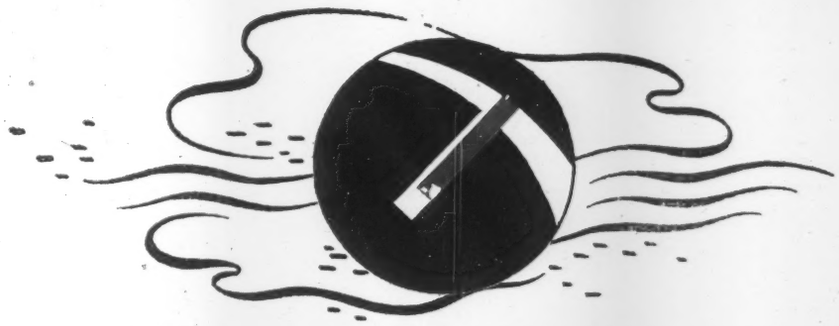
SHINYHEADS for hexagon head cap screws of high carbon C-1038 steel, full-finished, bright, shiny heads.

The FERRY CAP & SET SCREW Co.

2177 SCRANTON ROAD • • • • • CLEVELAND 13, OHIO

Pioneers and Recognized Specialists Cold Upset Screw Products since 1907

CAP AND SET SCREWS • CONNECTING ROD BOLTS • MAIN BEARING BOLTS • SPRING BOLTS AND SHACKLE BOLTS • HARDENED AND GROUND BOLTS
SPECIAL ALLOY STEEL SCREWS • VALVE TAPPET ADJUSTING SCREWS • AIRCRAFT ENGINE STUDS • ALLOY STEEL AND COMMERCIAL STUDS • FERRY PATENTED ACORN NUTS



JUST ABOUT as UN-COMPLEX as a SPOON

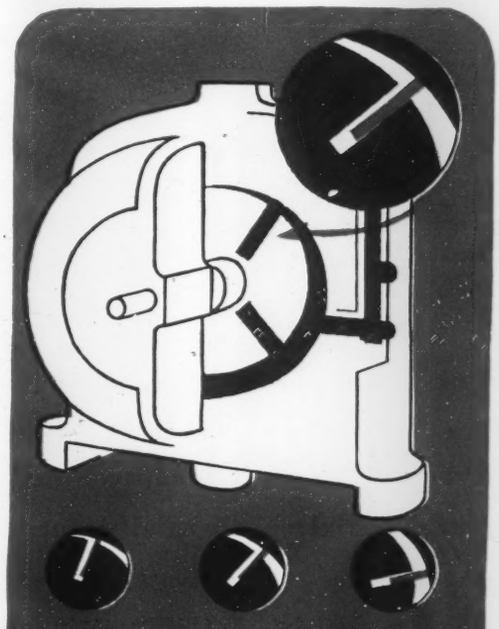
..the Gast Vacuum Pumps (to 28 in.), Compressors (to 30 lbs.), and Air Motors (to 1 h.p.)

Consider the spoon—a hollow with an extension attached. It does a magnificent job of materials handling . . . (Yet a far more complex device could be designed to do the same thing, and do it no better, and become an operating problem in itself.)

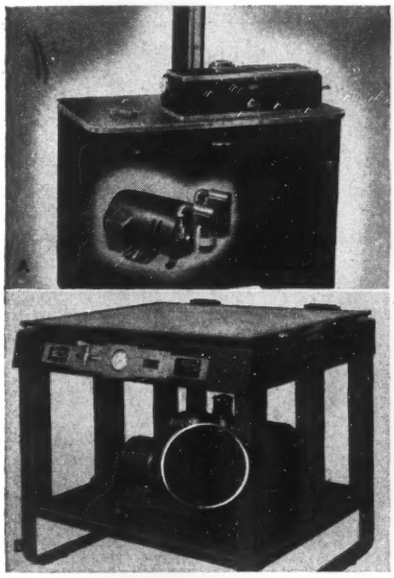
Much the same simplicity is seen in Gast design . . . a slotted rotor containing one-piece vanes . . . which slide outward and sweep the cylinder walls because centrifugal force won't let them do anything else. Mark this: No valves. No reciprocating parts, no lost motion. No guides, rings, gears, hinges or adjustments. No means-to-assist-means . . . The list of things NOT found in a Gast is a long list indeed.

For that reason the Gast delivers MORE per pound of weight, MORE per horsepower. For that reason the Gast can be superbly built, yet reasonably priced. And for that reason the Gast requires next-to-no maintenance.

If you use air power on machines you build, or if you COULD use air power to better advantage (and very likely you could) then avail yourself of Gast application experience, and have the Gast's faithful performance benefiting you and the users of your machines ever after. GAST MANUFACTURING CORPORATION, Dept. B, 107 Hinkley St., Benton Harbor, Mich.



Vanes: Self-seating . . . self-adjusting . . . springless. Centrifugal force holds them against cylinder wall. They "work without works" . . . Continuous, non-pulsating flow. . . More air per pound of weight; more air per horsepower. . . . Forced-air cooling: long life, oil economy, no hot-oil odor . . . Automatic shaft seal: no packing, no leaking, no adjusting.



A

Gast Compressor in a Precision Gauge. Scale divisions are .00002 lb. each; Gast's steady pressure requires no pressure regulating means.

B

Gast Compressor used in a lithographer's printing frame.

ENGINEERING TEST OFFER —So You Can SEE IF YOU'RE MISSING SOMETHING!

Simply write our Engineering Department and explain the operation you think air might handle, or describe the job air is already doing for you. Our Engineering Department will study your problem, select or design a Gast unit to do the specified work at less cost or at greater efficiency or both. Then, **without cost** or obligation, the recommended unit will be shipped to you for your performance tests.

GET THIS IDEA-CATALOG

It not only tells how Gasts are built and all about them, but suggests uses that may not have occured to you. Write for it; no charge or obligation!

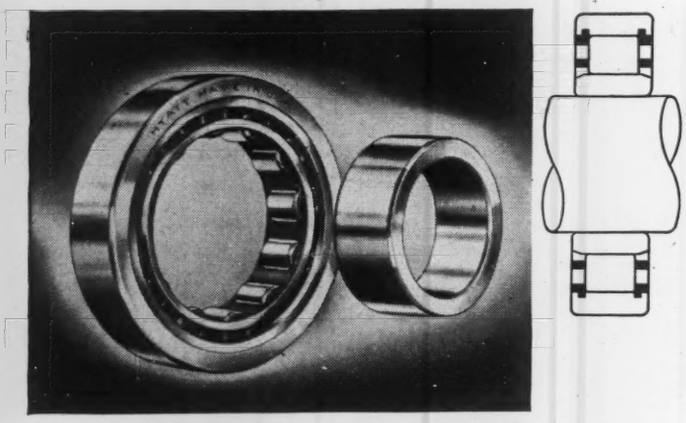
GAST ROTARY

1669

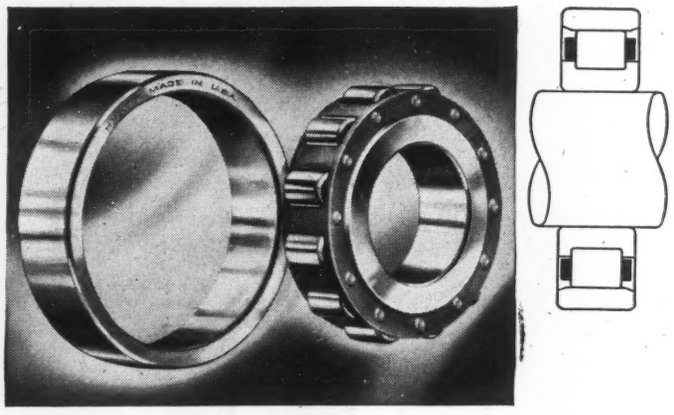
VACUUM PUMPS·AIR COMPRESSORS·AIR MOTORS

NEED A RADIAL BEARING THAT PERMITS AXIAL SHAFT MOVEMENT?

Hyatt has the Answers



A-TS HY-LOAD BEARING. Inner race is a straight cylinder and is separable. Rollers are retained with the outer race — radially by a one-piece separator, and axially by split, shouldered end rings.



BU-Z HY-LOAD BEARING. Outer race is a straight cylinder and is separable. Rollers are retained with the *inner* race — radially by a cage, and axially by flanges on the *inner* race.

THE straight cylindrical race in each of the bearings pictured above permits axial freedom of the shaft to accommodate thermal expansion or other limited shaft movement. This is but one of the advantages enjoyed by designers who know the Hy-Load line. Others include: option of omitted race operation, complete interchangeability of parts, maximum capacity for standard AFBMA dimensions — and long, trouble-free life.

Full information about all 10 types of Hyatt Hy-Load Bearings (including dimensions and load ratings) is in the new 88-page Hy-Load Catalog . . . a complete engineering guide to radial bearing selection and use. Write now for a free copy, without obligation. Hyatt Bearings Division, General Motors Corporation, Box 71B, Harrison, New Jersey.

HYATT ROLLER BEARINGS

Dayton Multiple V-Belt Drive transmits power to sand conditioning blade

Drudgery of sand conditioning—the painfully slow method of shoveling—has been replaced by a modern, mechanized method. Now, a lawn mower type, cutting blade cylinder does the work easily, more uniformly. For fast, smooth and dependable power flow the designer specified a Dayton V-Belt Drive. And, as a result, uniform sand conditioning increases foundry production of better castings . . . at less cost per unit.

This is another of the many examples of the flexibility of Dayton V-Belt Drives. The capacity of Dayton V-Belt Drives to perform in excess of standard requirements—under all operating conditions—is another of the many reasons more industrial designers *consistently* specify *Daytons* for original equipment. A Dayton Power Transmission Specialist is ready to help you. Call or write: DAYTON RUBBER · DAYTON, OHIO.

NOW! * *Rayon Cords*

PROVIDE DAYTON V-BELTS WITH

1. Minimum Stretch 2. Greater Flex Strength 3. Longer V-Belt Life

* Rayon cords are *specially processed* by Dayton for use in V-Belts to provide the most efficient and economical power transmission service for your machine needs. For the complete story write for booklet A-469.

Dayton Rubber

THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

THE WORLD'S LARGEST MANUFACTURER OF V-BELTS

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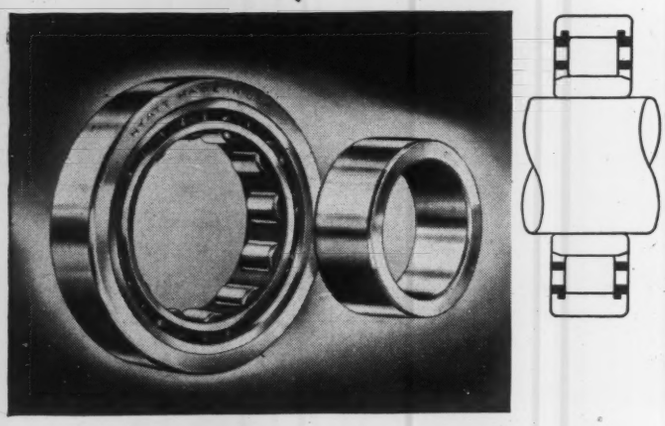

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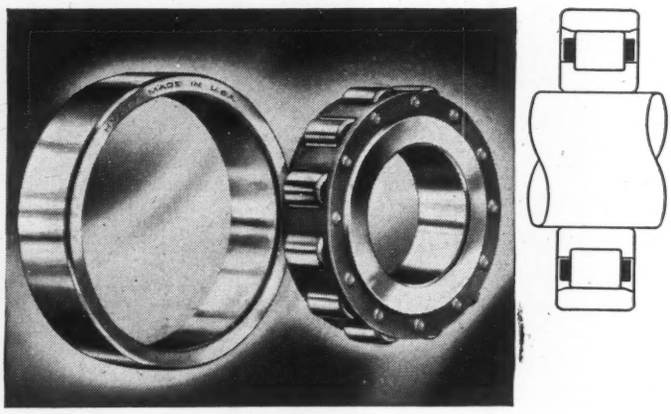

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1. Minimum Stretch 2. Greater Flex Strength 3. Longer V-Belt Life

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Dayton Rubber

THE MARK OF TECHNICAL EXCELLENCE IN NATURAL AND SYNTHETIC RUBBER

THE WORLD'S LARGEST MANUFACTURER OF V-BELTS

★ EXCELLENT ★

AGE RESISTANCE

RESILIENT parts made from HYCAR American rubber resist the aging effects of air, sunlight, ozone, heat, cold, and all other types of oxidation. That's why they *stay* resilient—and stay on the job for a long, long time.

Other important properties of HYCAR American rubber are shown in the box at the right. And it's important to know that these properties may be had in an almost limitless number of combinations—each compounded to meet a given set of service conditions.

We make no finished products of HYCAR. But we urge you to ask your supplier for parts made from this versatile material. You'll learn for yourself that it's wise to use HYCAR—in difficult or routine applications—for long-time, dependable performance. For more information, please write Dept. HN-5, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

CHECK THESE SUPERIOR FEATURES OF HYCAR

1. *EXTREME OIL RESISTANCE — insuring dimensional stability of parts.*
2. *HIGH TEMPERATURE RESISTANCE—up to 250° F. dry heat; up to 300° F. hot oil.*
3. *ABRASION RESISTANCE—50% greater than natural rubber.*
4. *MINIMUM COLD FLOW—even at elevated temperatures.*
5. *LOW TEMPERATURE FLEXIBILITY — down to —65° F.*
6. *LIGHT WEIGHT—15% to 25% lighter than many other synthetic rubbers.*
7. *AGE RESISTANCE—exceptionally resistant to checking or cracking from oxidation.*
8. *HARDNESS RANGE—compounds can be varied from extremely soft to bone hard.*
9. *NON-ADHERENT TO METAL—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)*

Hycar

Reg. U.S. Pat. Off.

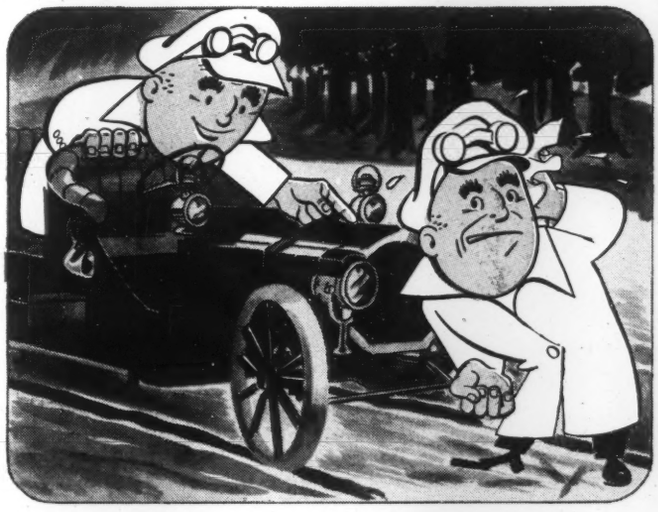
American Rubber

B. F. Goodrich Chemical Company

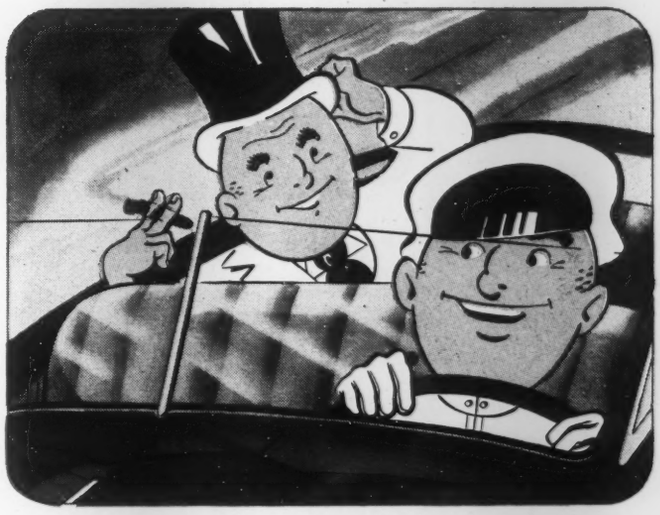
A DIVISION OF THE B. F. GOODRICH COMPANY

GEON polyvinyl materials • HYCAR American rubber • KRISTON thermosetting resins • GOOD-RITE chemicals

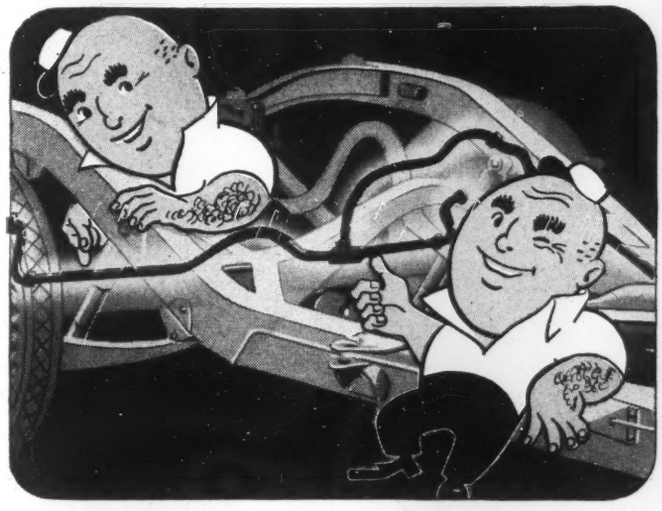
Keeping drivers off their feet



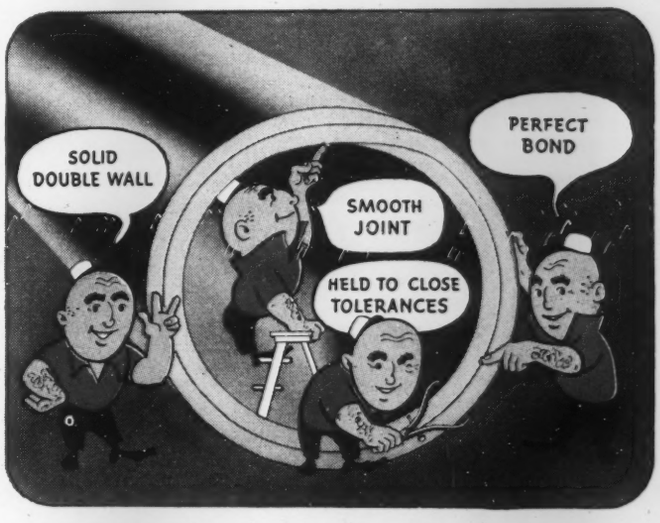
1. **NOT** too far back in automotive history, an hour's ride was an expedition. Driving took a strong arm on the wheel and a stronger one on the crank. It was never unusual to get out and get under. Mechanical breakdowns were frequent and many a rider was forced to walk.



2. **TODAY'S** cars are marvelous for dependability and riding comfort. From bumper to bumper, every part has been improved to make motor cars more economical, more efficient and easier to drive. It is startling to think how seldom the modern motor car leaves its driver stranded.



3. **EACH** motor vehicle rolling off our production lines has an average of more than twenty Bundy Tubing parts. Industry also calls on Bundyweld to carry refrigerants in cooling devices, gas in modern kitchen ranges and fluids in many kinds of beverage and food processing equipment.



4. **BUNDYWELD** is different from other tubing. A single strip of basic metal, coated with a bonding metal, is rolled continuously twice laterally into tubular form, then metallurgically bonded by intense heat—carefully controlled—to form a solid, double wall tube, held to close dimensions.

5. **IN HUNDREDS** of modern products where the need is for outstanding mechanical properties, designers and engineers have been quick to specify Bundyweld. Let Bundy Research and Engineering Departments illustrate the advantages of Bundy Tubing for YOU! Available in steel, Monel and nickel. Write: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

★ ★ ★ ★

ENGINEERED TO YOUR EXPECTATIONS

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES:

Pacific Metals Co., Ltd. 3100 19th St. San Francisco 10, Calif.	Standard Tube Sales Corp. 1 Admiral Ave. Maspeth, N.Y.C., N.Y.	Lapham-Hickey Co. 3333 W. 47th Place Chicago 32, Illinois	Rutan & Co. 404 Architects Bldg. Phila. 3, Pa.	Eagle Metals Co. 3628 E. Marginal Way Seattle 4, Wash.	Alloy Metal Sales Ltd. 861 Bay St. Toronto 5, Canada

GET A *Quicker* START

with the accurate, mirror-finish threads on

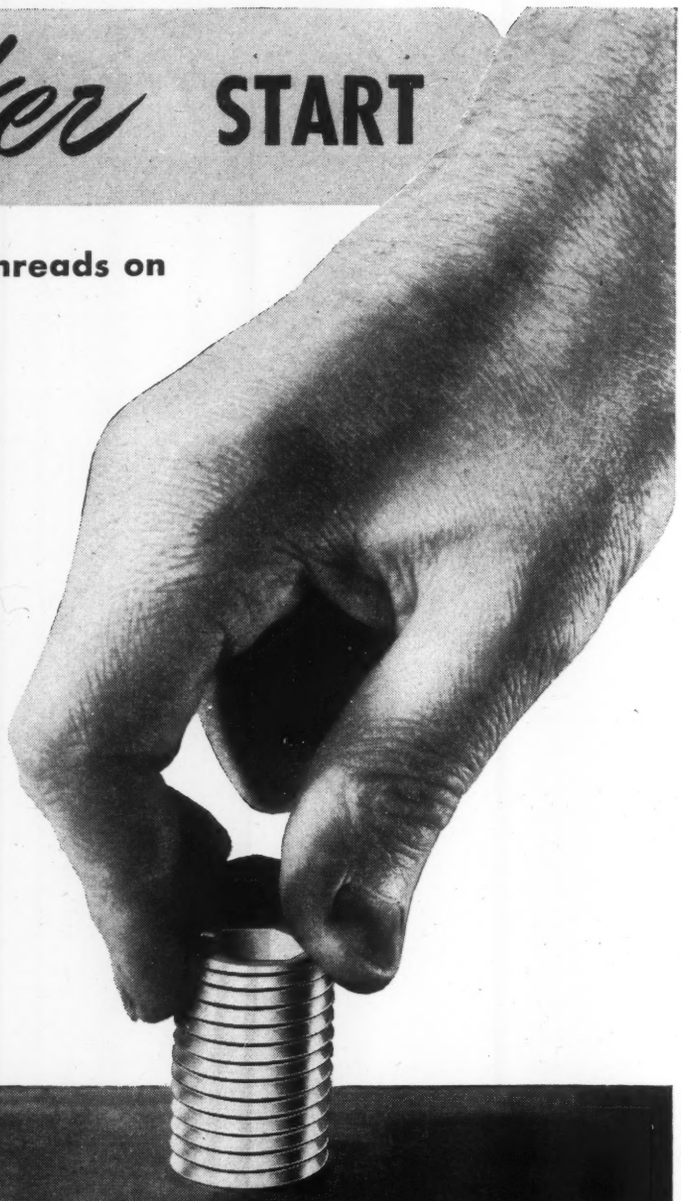
P-K GROUND THREAD SOCKET SET SCREWS

● Quick starting—less fumbling . . . these are benefits you can expect in assembly when you specify P-K Ground Thread Socket Screws. Made by a newly developed centerless grinding process pioneered by Parker-Kalon, these Socket Set Screws are a "shining example" of first class workmanship.

Ground on hardened blanks, the threads have the gleaming, mirror-smooth finish formerly seen only on expensive special screws. They are free from unsightly nicks, burrs, tool marks and other imperfections common to ordinary cut thread socket screws. And this assures faultless contour and lead with a uniform, dependable Class 3 Fit.

PROMPT DELIVERIES OF SOCKET SCREWS

You can get P-K Socket Set Screws NOW . . . and P-K Socket Head Cap Screws, too. No delays on deliveries. Production's high. Stock's ample. Start right away to profit by the many advantages of these improved socket screws.



PARKER-KALON *cold-forged* SOCKET SCREWS

COMPARE

With this free SAMPLE KIT, you can make your own comparison. See why P-K Socket Screws are 3 ways better—why more and more manufacturers are using them to save time and trouble, improve their products. *Write today! Parker-Kalon Corp., 200 Varick St., New York 14.*

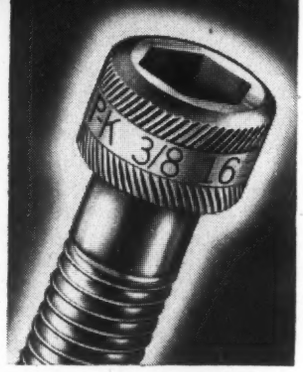
ANOTHER P-K FIRST

*☆ Size-Marked-Gear Grip**

SOCKET HEAD CAP SCREWS

Eliminates Gauging or Guessing. Size-Mark shows correct size at a glance. Saves time and errors at tool crib or on assembly line.

Prevents Slipping. Gear Grip provides sure grip even when fingers are oily, makes fingers fly faster.



**U. S. Pat. No. 126,409*

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GILMER HAS THE PULL
Gilmer
ENGINEERING SERVICE
can help you with your
power transmission problems
When you have a machine design problem that concerns belts or belting, Gilmer engineers can help you find the right answer. Their vast experience in the design, construction and application of belts for every type of drive is available without charge or obligation.
Whether the application calls for V-Belts (multiple or F.H.P.), Flat Belts or Special Purpose Belts . . . for light or heavy duty, low or high speed . . . there is a Gilmer Belt to fit the need.
And wherever Gilmer Belts are used as original equipment, buyers of the product can obtain replacement belts easily and promptly, for Gilmer distributors are located in all parts of the country.
The Gilmer line is listed and described in Sweet's Design Catalog. For more detailed information send for FREE copies of the Gilmer Catalogs. They contain much supplementary data which you will find helpful.
L. H. GILMER COMPANY, Tacony, Philadelphia 35, Pa.
Division of United States Rubber Company
Gilmer BELTS
THERE IS A GILMER POWER TRANSMISSION BELT FOR EVERY NEED
MULTIPLE V-BELTS
KABLE KORD FLAT ENDLESS BELTS
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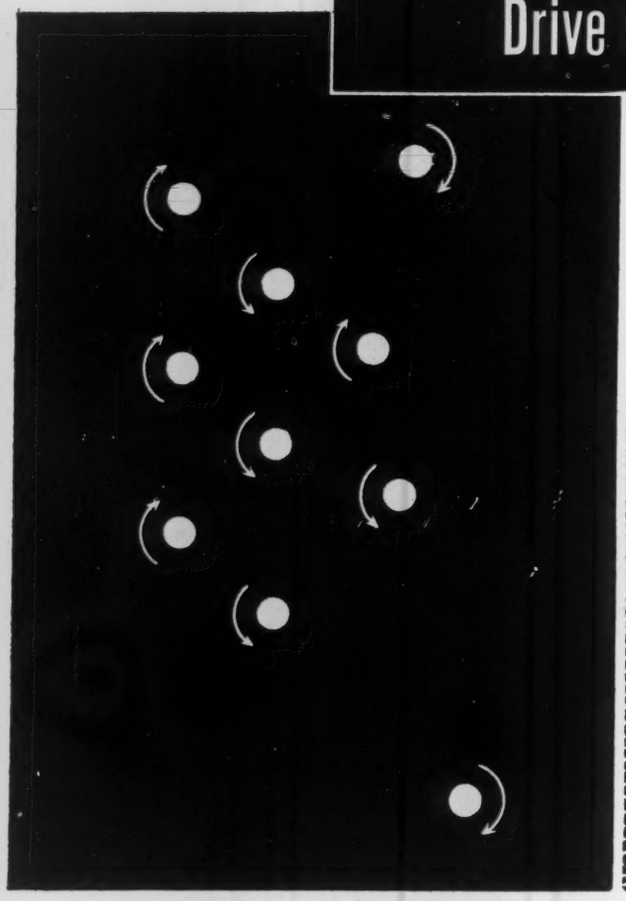
SPECIAL INDUSTRY BELTS

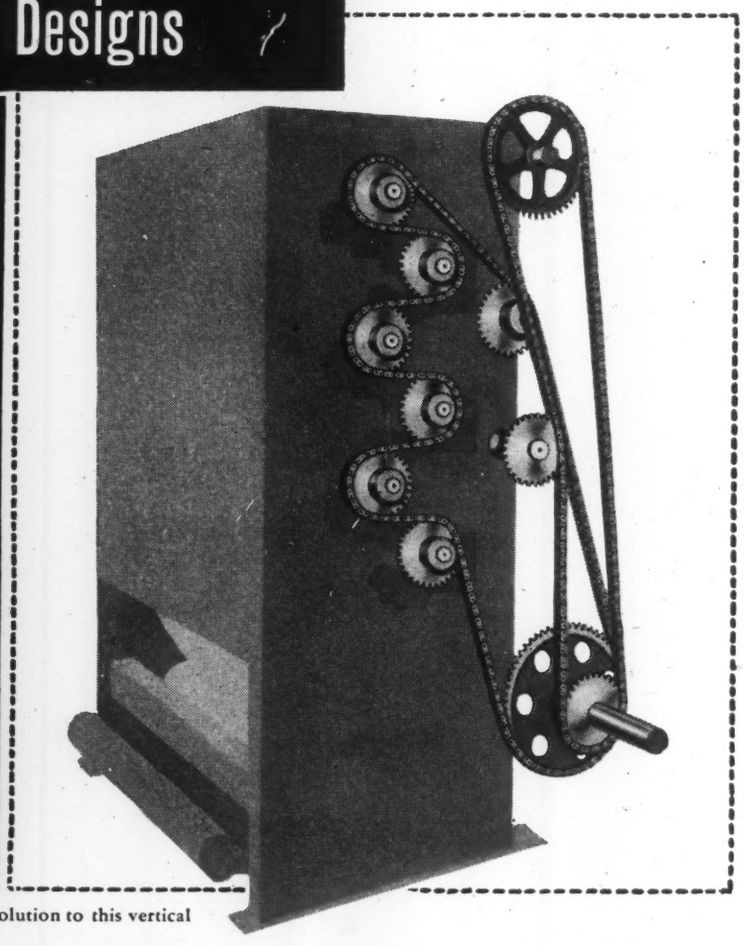
Where Shafts must turn . . .

Whitney

ROLLER CHAINS AND SPROCKETS

Solve Your Complicated Drive Designs





Whitney Roller Chain provided the solution to this vertical brush drive problem.

Whether it is a vertical brush drive or a horizontal boring mill, the *flexibility* of Whitney Roller Chain Drives makes them the first choice of designers for use in all types of equipment, standard or special.

Whitney Roller Chains . . . *the all steel drives* . . . deliver full power because there is no slippage, and friction loss is negligible. The cushioning effect of the roller chain construction plus the ruggedness and toughness of Whitney Chains withstands shock loads. Operating slack on short or long centers, Whitney Chains do not impose unnecessary tension loads on shafts or bearings.

Teamed up with these efficient chains are accurately made Whitney Cut Tooth Sprockets . . . correctly designed to insure smooth, quiet performance and maximum operating efficiency.

Investigate versatile Whitney Roller Chain Drives for your designs. Our engineers will help you with your drive problems. Write:

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AND MANUFACTURING COMPANY
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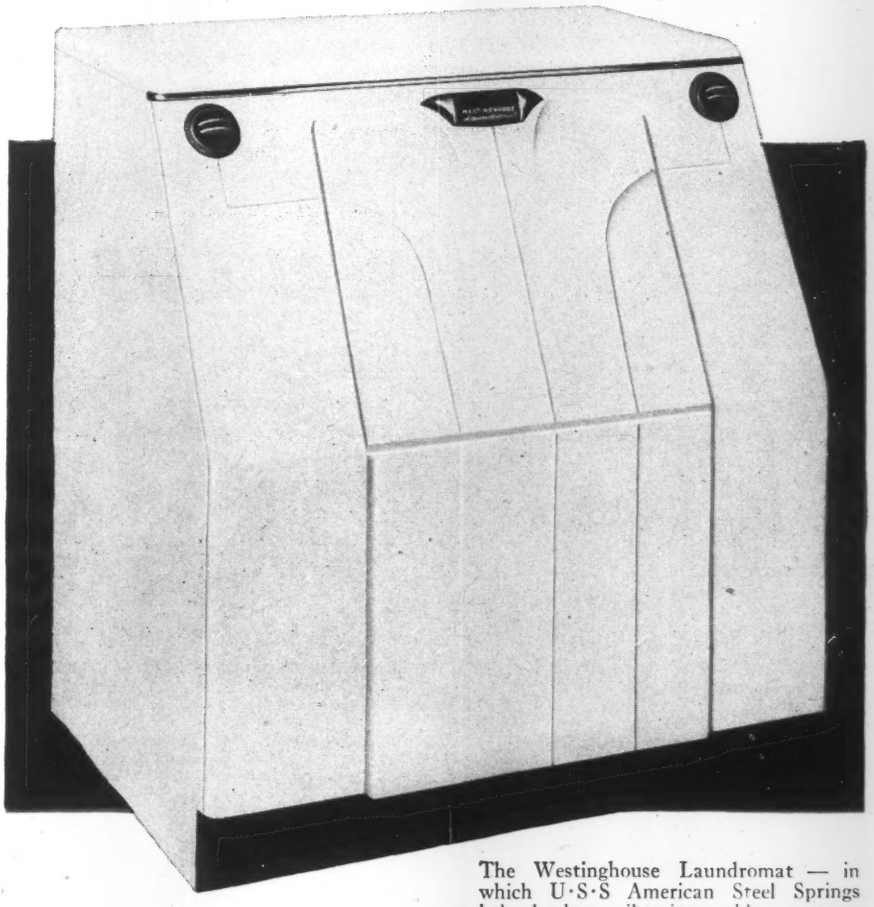
A PROBLEM:

TO ELIMINATE OBJECTIONABLE VIBRATION

A SOLUTION:

U·S·S American Quality Springs



The Westinghouse Laundromat — in which U·S·S American Steel Springs helped solve a vibration problem.

One of the requirements in the design of this Westinghouse automatic clothes washer was to eliminate objectionable vibration. This was achieved, in part, by suspending the unit inside the casing by 3 specially-designed springs. And Westinghouse, like numerous other product manufacturers requiring tailor-made springs, uses U·S·S American Quality Springs.

Combining quality steel with modern spring engineering, these springs provide extra stamina to resist dynamic stresses caused by unbalanced loading, surging and other operating conditions. And because they are tailor-made *to meet your specifications exactly*, you can be sure that they will perform as expected.

Our engineers and research men will be glad to cooperate with you in solving *your* spring problem.

Remember that *better springs make better products*—so choose U·S·S American.

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

Columbia Steel Company, San Francisco,
Tennessee Coal, Iron & Railroad Company, Birmingham,
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UNITED STATES STEEL

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U·S·S American Quality Springs

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. . . and self-lubricating packing both are made of versatile Vistex

Vistex was developed originally as a peak or visor for caps. Later Vistex was perfected as a reciprocating seal for aviation shock absorbers. It is the strong new member of the American Felt family of versatile, felt base materials.

Vistex is sheet laminated in multiple ply thicknesses or synthetic or natural rubber impregnated felt, available in four standard types for varying applications. High operating and maintenance efficiency are assured . . . without danger of premature failure from overheating, accelerated aging, decomposition or dimensional distortion in maintenance reassembly.

Controlled ratio of felt fibre to impregnant in Vistex, plus standard density for all thicknesses, provides a self-lubricating sealing material that is well adapted to packing-washers and heavy-duty-bearing seal applications.

Please write, on your letterhead, and ask for Data Sheet No. 14, "Vistex Packings — Gasket — Seals."

AMERICAN FELT COMPANY DATA SHEETS

Write for those you need to complete your Felt reference file.

- No. 1—Felt Density and Hardness
- No. 2—Adhesives for Felt Application
- No. 3—"K" Felt—Sound Absorption and Thermal Insulation
- No. 4—Special Felt Treatments
- No. 5—S.A.E. Specifications and U. S. Navy 27F7
- No. 6—Felt and Lubrication
- No. 7—A.S.T.M. Methods of Test for Wool Felt, D461
- No. 8—U. S. Army Specification No. 8-15G
- No. 9—Sheet Felts, Standard Grades and Specifications
- No. 10—Vibration Isolation With Felt
- No. 11—Felt Seals, Their Design And Application
- No. 12—Flame-proofed Felt
- No. 13—Felt in Compression
- No. 14—Vistex—Packings, Gaskets, Seals

American Felt Company

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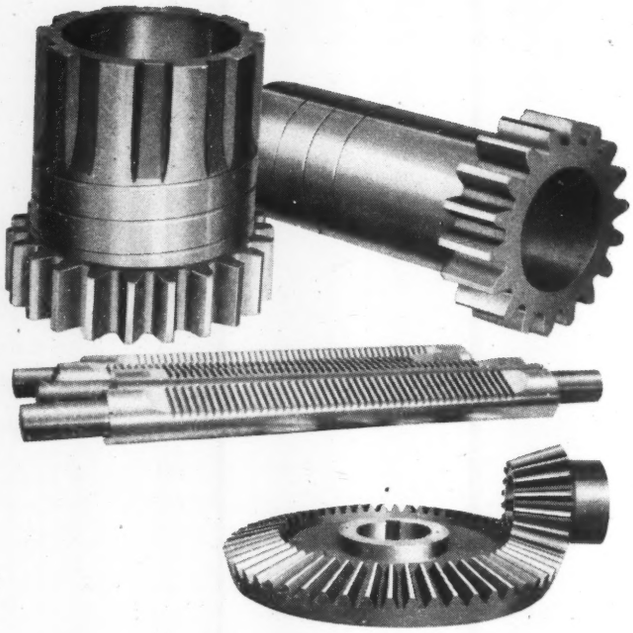

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for high quality GEARS made exactly to your specifications

Regardless of quantity or type, you'll profit by specifying Adams custom made gears for your product. Made on the most modern gear cutting machines by skilled workmen, Adams gears are quality controlled to guarantee exact conformance to your specifications. Write for further information, today. THE ADAMS COMPANY, 1942 Market St., Dubuque, Iowa.

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- Helical Gears
- Bevel and Miter Gears
- Worms and Worm Gears
- Internal Gears (spur and helical)
- Sprockets
- Ratchets
- Splined Shafts
- Racks
- Lead and Feed Screws
- Ground Tooth Gears (spur and helical)
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Dubuque, Iowa, U. S. A.

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GEARS

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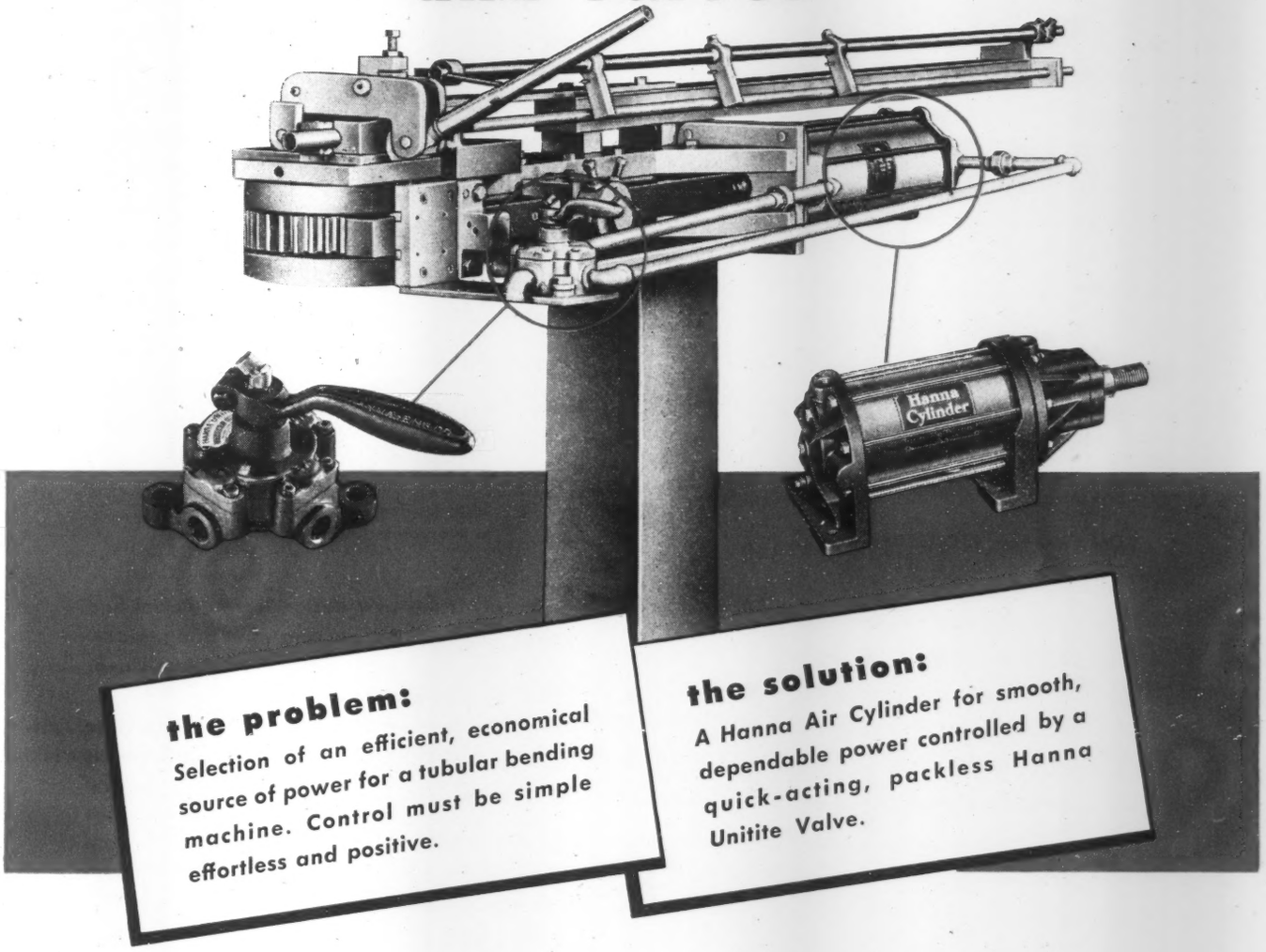
Hanna *Air* Cylinders

and Valves



the problem:
Selection of an efficient, economical source of power for a tubular bending machine. Control must be simple effortless and positive.

the solution:
A Hanna Air Cylinder for smooth, dependable power controlled by a quick-acting, packless Hanna Unitite Valve.

Typical of the 1001 possible applications for Hanna Air Cylinders and Valves wherever work must be done is their application to the Bend-Ex Tubular Bending Machine. Manufactured by Paul Machine Tool and Die Works, this machine is designed especially for the manufacture of tubular furniture. The Hanna Air Cylinder provides the "push" necessary to make the bend... The Unitite Valve makes possible single lever control for all bending and turning operations. The troublesome clutch and brake mechanism of ordinary bending machines is completely eliminated.

Wherever a controlled push, pull, lift, press, clamp or control is needed, Hanna Air Cylinders will do the job efficiently and smoothly, eliminating manual effort or replacing less efficient and more complicated methods.

Ask for Catalog 234; it gives complete data on all Hanna Air Cylinders.

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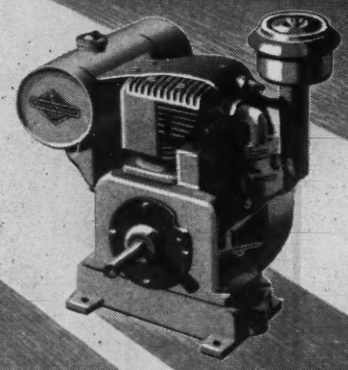

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The experience of an organization which has produced more than 2¾ million air-cooled engines is built into every Briggs & Stratton engine. Theories or hopes do not dictate the adoption of designs, materials or manufacturing methods — *actual experience and long testing do* . . . The experience of users proves that Briggs & Stratton engines stand up under all kinds of service — year after year — proof that they are *designed right — built right — the right power for your equipment.*

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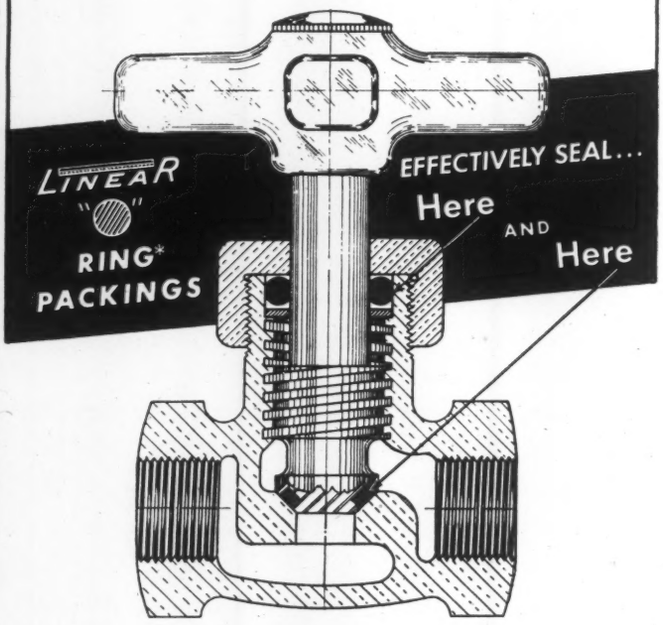

Sectional view of shower valve redesigned to incorporate Linear "O" Ring Packings.

Not only is this new design more efficient and more compact, but packing wear and replacement are materially reduced by use of Linear "O" Rings which:

1) Provide a more effective seal; 2) require no tools to install since no wrench pressure is needed to maintain the seal; 3) permit uniform handle torque from one valve to the next since "O" Ring pressure against the shaft is constant and non-adjustable; 4) eliminate the cap gasket because both cap and stem are sealed by the same "O" Ring; 5) require no retaining screw; 6) cannot be damaged by over-tightening, thereby, increasing packing life and assuring drip-free faucets.

**Covered by Christensen United States Patent No. 2,180,795; all "O" Rings sold by Linear are manufactured under royalty agreement with patentee.*

Linear "O" Rings are adaptable to a wide range of design applications. Our engineering facilities are available to help you now with your own design problem. Write today.

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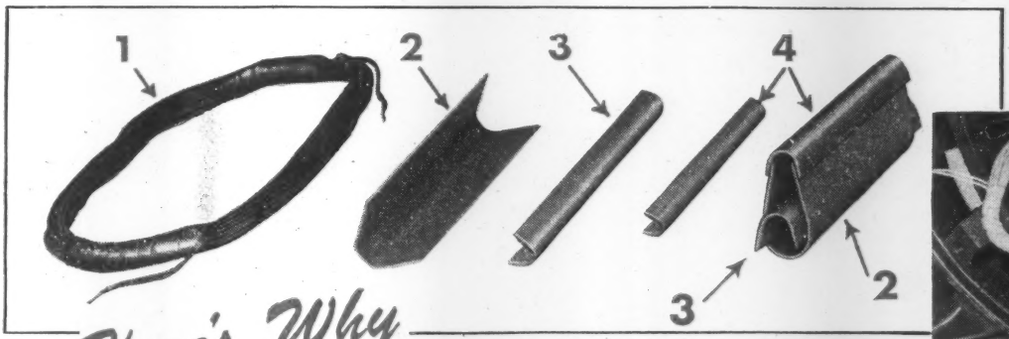
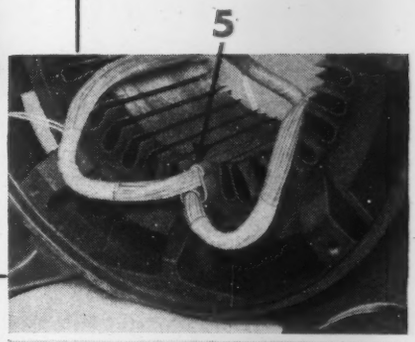
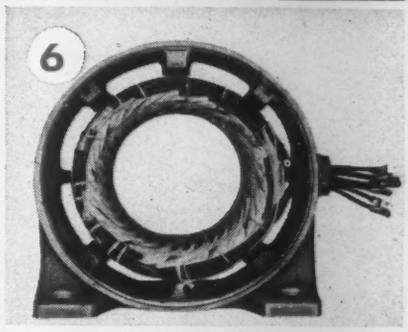
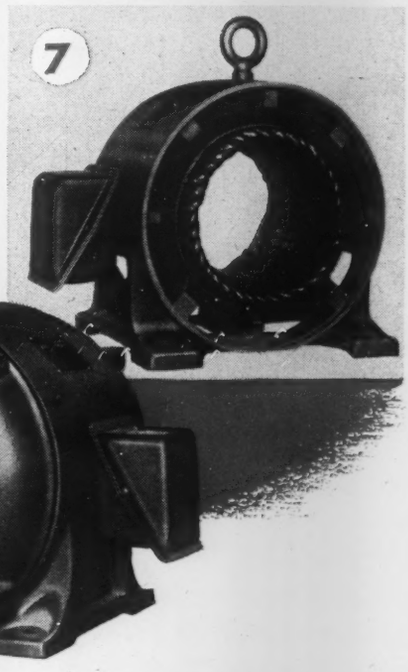




Here's Why

Century Motor Insulation Contributes to Long Life





Windings and Insulation Are Built Into a Rigid Mass That Is Highly Resistant to Moisture and Abrasion

One of the important reasons why Century motors stay on the job is that they are so well protected to resist moisture and abrasion — hazards that often cause motor burnouts. The following information on Century motor insulation shows how Century engineers have solved the problem.

No. 1 — The insulation on the wire insulates between turns of the coil.

No. 2 — A combination of heavy fish paper and varnished cloth with high dielectric strength forms the slot insulation. This insulates the coil from the stator iron.

No. 3 — Fish paper formed to the correct contour and size insulates the coils from each other in the slot.

No. 4 — The "U" shaped fiber wedge draws the edges of the slot insulation together, closing the insulation cell, holding the coils in the stator iron — and wedging the coils rigidly in the slot.

No. 5 — Shows how the coils are fitted into each slot together with the three pieces of insulation.

No. 6 — Shows the stator after the winding job has been completed, but before it has been dipped into the insulating compound. Notice the neat compact job of inserting and connecting the coils and lead wires.

The stator is then dehydrated in an oven, and immediately thereafter dipped into Century's special insulating compound and then baked. After each stator is thoroughly baked, repeating this process as necessary, it is given a final coat of heavy air drying varnish for mechanical protection.

No. 7 — The final result is a rigid mass that is thoroughly insulated — highly resistant to moisture and abrasion. The individual wires are held together and sealed to the stator core, eliminating chafing between wires and between coils and stator iron.

Century builds a complete line of electric motors and generators, fractional and integral horsepower, in the popular sizes to meet the requirements of industrial production, commercial uses and appliance applications.

Specify Century for all your electric power requirements.

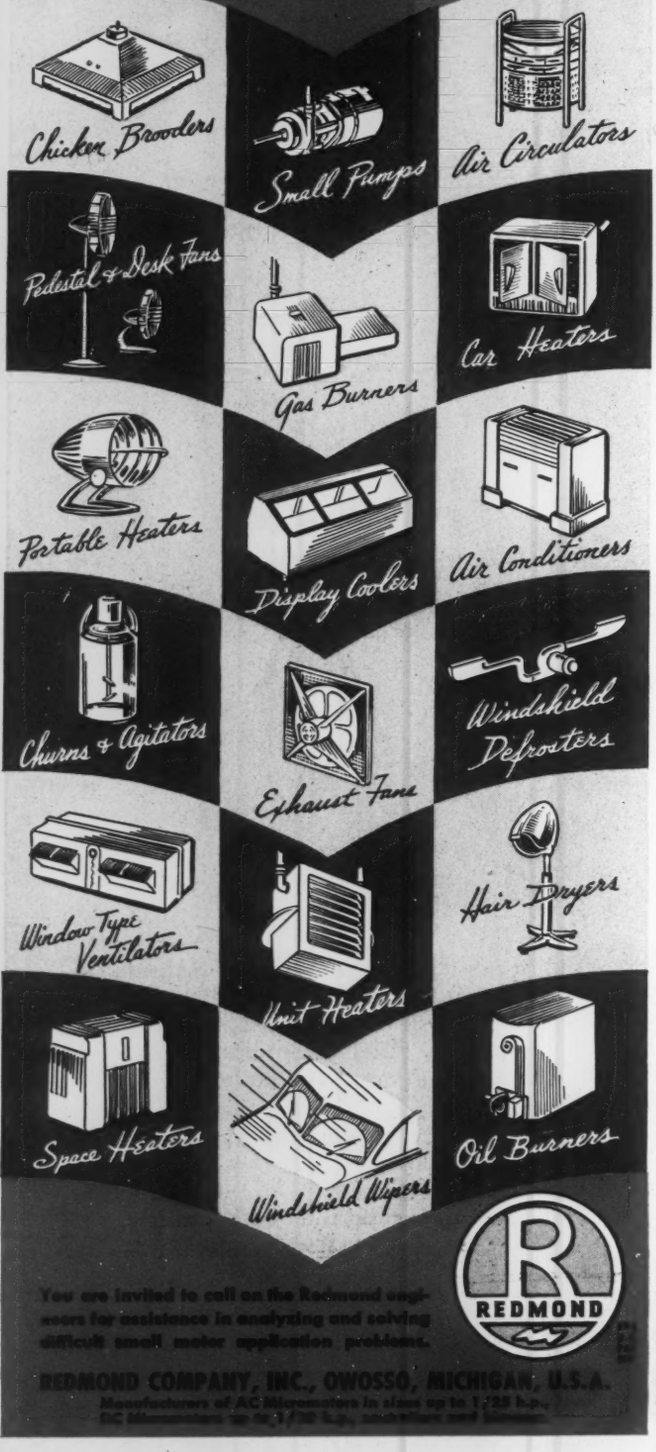
Century C Motors

CENTURY ELECTRIC COMPANY • 1806 Pine St., St. Louis 3, Mo. 533

Offices and Stock Points in Principal Cities

Practical Redmond MICROMOTORS

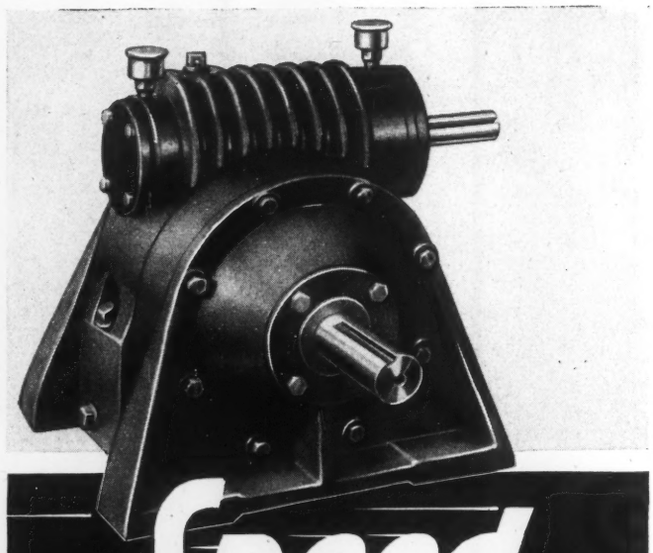
A few of the many products to which long-life Redmond Micromotors are readily adaptable are illustrated below.



You are invited to call on the Redmond engineers for assistance in analyzing and solving difficult small motor application problems.

REDMOND COMPANY, INC., OWOSSO, MICHIGAN, U.S.A.

Manufacturers of AC Micromotors in sizes up to 1/25 h.p.
DC Micromotors up to 1/30 h.p., gearheads and blowers



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Do You Know...

Janette Builds BOTH Motorized and Motorless Speed Reducers.

32 styles and types of motorized and 20 motorless machines are available with foot or flange bases.

Janette built motors are designed specially for driving Speed Reducers.

Various types of motor enclosures, modifications, voltages, phases and speeds can be furnished.

All Motors and Reducers are Built to ONE Standard of Quality.

Janette — 1/30 to 7 1/2 H.P. .08 to 447 R.P.M.

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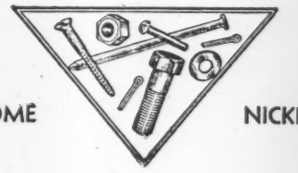
Castleton . . 2511



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AN OPEN LETTER TO NERO WOLFE, DETECTIVE, GOURMET, AND ORCHIDIST

Mr. Nero Wolfe
c/o AMERICAN MAGAZINE
New York, New York

Dear Mr. Wolfe:

In a recent report on your activities, chronicled by your estimable assistant, Mr. Archie Goodwin, under the title "Before I Die", you are recorded as having been approached by a character involved in sundry black market operations. Mr. Goodwin further states that you asked this character to obtain for you some "stainless steel ... bolts and nuts ... rivets".

We admire your perspicacity in realizing the superiority of stainless steel products, just as we admire your investigatory abilities. But, while we are fully aware that you were only testing the capacity of this character, we think you should know that no one has to resort to illegalities when searching for stainless steel bolts, nuts, rivets, or other fastening devices. Our stock room is full of them, in all shapes and sizes, and we'll be glad to provide all you need.

We'll be delighted to send you, or anyone else, a copy of our catalog and our current stocklist, on request. Or, if your needs are for some special analysis or specification, we'll be glad to manufacture the fastenings you wish, in a very short time.

We've been making stainless steel fastenings for twenty years, and we think that our reputation, in our particular field, compares favorably with yours in the field of detection.

Sincerely,

R. F. Mack

Richard Mack
Treasurer
Anti-Corrosive Metal Products Co., Inc.

Manufacturers of

NUTS · BOLTS · RIVETS · WOOD SCREWS · MACHINE SCREWS · LOCK WASHERS · COTTER PINS · NAILS
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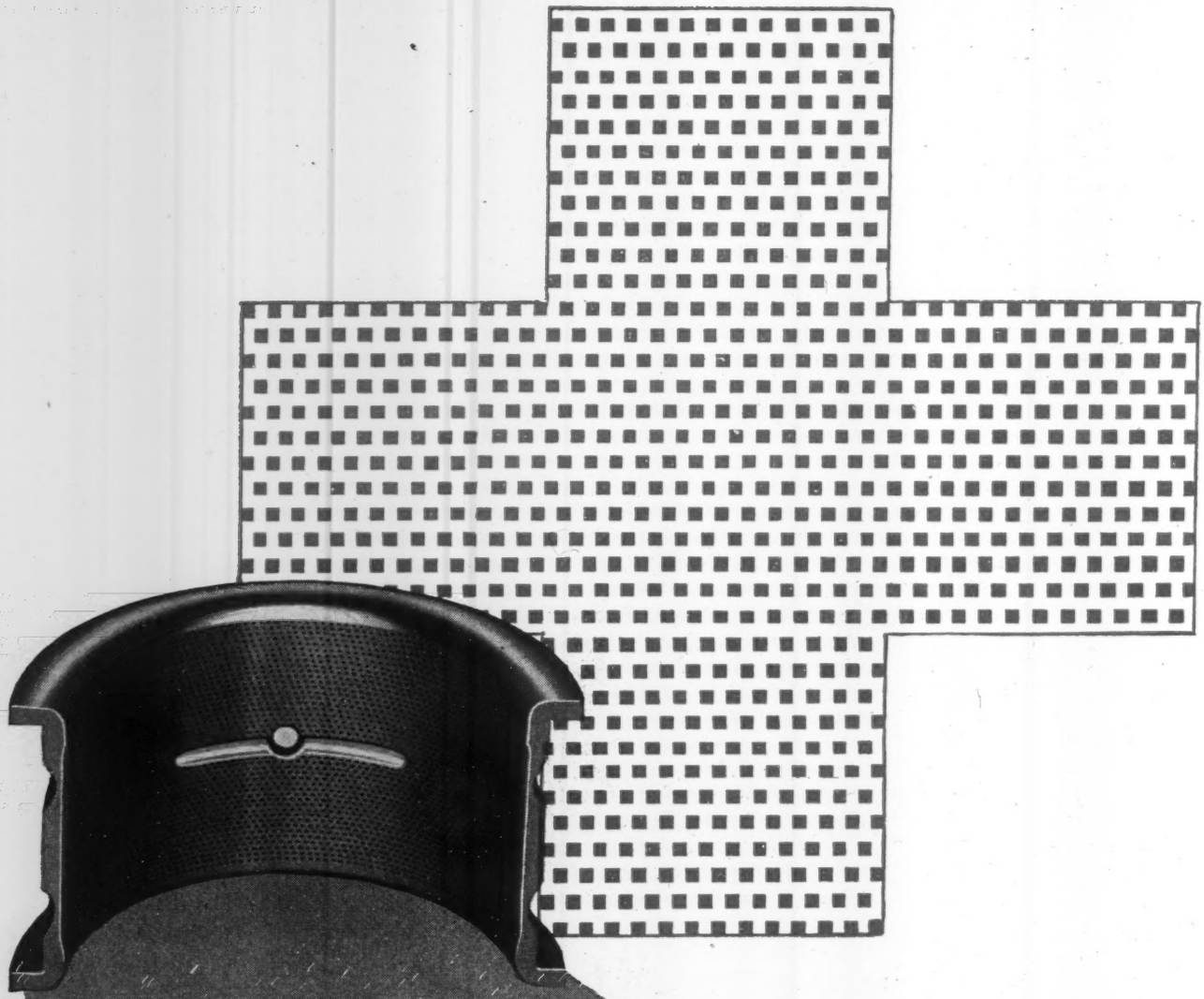
Anyone else who would like a copy of our catalog and our current stocklist? Write Anti-Corrosive Metal Products Co., Inc., 57 River Road, Castleton-on-Hudson, N. Y.



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When damage through overstress occurs, the frictional heat will melt some of the silver babbitt metal. It will flow out of the grids and spread over the damaged area, restoring a good bearing surface.

Where high strength, fatigue resistance, and embedability count, centrifugally-cast N-B-M Gridded Bearings add safety and protection for the shaft.

Our exclusive new manufacturing process now makes them available at "mass-production" savings. May we send you complete engineering data?

N B M

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

1. Control Instruments

Taylor Instrument Cos. — 8-page illustrated catalog No. 800 contains data on various instruments designed for automatic control of temperature, humidity and air circulation in lumber dry kilns. Control systems and operating procedures are covered.

2. Centrifugal Castings

Shenango-Penn Mold Co.—8-page illustrated bulletin No. 143 is descriptive of centrifugally cast bronzes, Monel metal and alloy irons. Available sizes, applications and manufacture of castings are covered. Chart shows comparative government and standard specifications, desired chemical analyses, average or minimum physical properties and applications of ferrous and nonferrous alloys.

3. Rubber Products

Aetna Rubber Co.—12-page illustrated booklet entitled "Aetna Rubber Service" deals with manufacturing facilities, Saniseal refrigeration cabinet lid assemblies, molded hard and soft rubber knobs, and other molded, extruded and bonded rubber products.

4. Stainless Steels

Crucible Steel of America — Folding data chart lists type analyses; physical, electrical and mechanical properties; heat resistance; hardness and working characteristics of Rezistal stainless steels.

5. Metal Stampings

American Emblem Co. — 4-page illustrated folder gives information on metal stampings which include decorative panels and trim, radio escutcheon plates and nameplates. Available metals include platinum, gold and its alloys, sterling silver, beryllium copper, stainless steel, aluminum, magnesium, brass, copper, nickel silver, pure nickel and all alloys of low carbon steel.

6. Hydraulic Power Unit

Vickers, Inc.—4-page illustrated bulletin No. 46-48 provides information on hydraulic Power Pack, hydraulic power unit, its uses, features, advantages and operation. Specifications, installation and performance data on this unit for lifting, lowering, pushing, pulling, stacking, loading and holding are included.

7. Thermostats

Stevens Mfg. Co.—4-page illustrated folder describes type S adjustable and non-adjustable bi-metal thermostats with temperature range from 0 to 650 F for 15-ampere, 115-volt alternating current operation. Suggested applications, principles of operation and typical calibration curves are included.

8. Variable Speed Drive

Dynamatic Corp.—18-page illustrated bulletin No. 4 provides information regarding principles and uses of eddy current coupling for variable speed drives. Other applications include absorption and motoring dynamometers, eddy current brakes and alternating current combinations. Ajusto-Spede motors supplied in sizes of from 1 to 75 horsepower at 1800 revolutions per minute are covered.

9. Bearing Bronze

Bearium Metals Corp. — 6-page illustrated folder entitled "Bearium Metal" describes bronze for bearings, bushings, thrust washers and for services involving rubbing friction. Metal is available in rough-cast bars, special castings, centerless-ground rods and machined parts.

10. Cemented Carbides

Kennametal, Inc.—64-page illustrated catalog No. 47 covers such cemented carbide products as standard and screwed-on blanks, chip breakers, grinding tools, milling cutters, step and axial face Kennamills, saws, router bits, Kennadrills for masonry, centers, half-centers, deburring files and extruded shapes and rolls.

11. Fastening Device Testing

Elastic Stop Nut Corp. of America—16-page illustrated booklet entitled "Test Procedure" by Dr. J. A. Sauer describes procedure for testing locking effectiveness of self-locking nuts and related fastening devices. Equipment and procedures for making tests for vibration, installation and removal torque, re-use torque, wearing and plating are discussed.

12. Stud Welding

Nelson Sales Corp.—36-page illustrated data book describes automatic stud welding process, equipment and studs and lists specifications and physical properties of flux-filled studs. Typical stud welding applications in automotive, construction, boiler and tank, railroad, electrical equipment manufacturing and metalworking fields are shown.

13. Connectors

Cannon Electric Development Co.—76-page illustrated catalog entitled "Cannon Plugs for the Electric Circuits of Industry" discusses assembly, servicing, maintenance and portability of electric equipment through use of connectors. Industries covered include communications, power, automotive, aviation, textile, mining and petroleum.

14. Machine Drives

Speed-Drives, Inc.—26-page illustrated booklet entitled "Power-Flo Products" presents data on precision built machine drives from ⅓ to 20 horsepower with ratios of 1:1, 1¾:1, 3:1 and 4:1. Drives are adaptable to new machines such as conveyors, mixers, blower fans and extractors and to special machines.

15. Fluid Handling Equipment

J. A. Zurn Mfg. Co.—4-page illustrated bulletin No. 46-2 is descriptive of disk, plug, horizontal tube, angle, pressure, suction and Y type strainers available in various metals and alloys and in coated, plated or lined adaptations of these metals.

16. Couplings

Philadelphia Gear Works — 16-page illustrated bulletin No. 150 contains details of steel flanged, flexible, Philflex Oldham, Thermoid, Waldron, Francke and Ajax type couplings. Gears, nonmetallic pinions, speed reducer units and various other products are described briefly.

17. Bronze Casting Alloys

American Manganese Bronze Co.—50-page illustrated reference book explains compositions, characteristics and applications of bronze castting alloys and aids in selection of proper alloys for any general application.

18. Solderless Wire Connectors

Solar Electric Corp.—2-page illustrated data sheet describes Scru-Its, molded plastic solderless wire connectors, available in fixture, junior, standard and large sizes for use with Nos. 10 to 18-gage solid or stranded wire or combinations of these wires.

19. Castings

Utica Radiator Corp.—4-page illustrated folder discusses company's facilities for producing magnesium, aluminum and gray iron castings. Five-page supplement covers availability, machineability, mechanical properties, corrosion-resistance and applications of magnesium alloys.

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20. Solderless Wiring Devices

Aircraft-Marine Products Inc.—28-page illustrated data book displays various types of solderless terminals, their features and applications. Graphic terminal selector chart and actual samples of solderless terminals are included.

21. Gears

Fellows Gear Shaper Co.—12-page illustrated booklet describes 16-millimeter, two-reel sound motion picture entitled "The Art of Generating and Gear Manufacturing Equipment" which deals with theory, design, tooth action and contact of gears and their production and inspection.

22. Sealing Device

Durametallic Corp.—50-page illustrated manual deals with Dura Seal mechanical sealing device designed for sealing rotating shafts on rotary and centrifugal pumps, mixers, agitators and contactors where leakage must be held to minimum, where pressures and shaft speeds are extremely high and where corrosive and abrasive conditions exist.

23. Socket Screws

Parker-Kalon Corp. — Illustrated bulletin form 481 describes and covers advantages of use of cold forged socket screws which are size-marked and have ground threads. Method of production and comparative features with other types are discussed.

24. Small Ball Bearings

Miniature Precision Bearings, Inc.—4-page illustrated folder No. 4b/1 gives specifications and other data on radial, super-light, pivot, angular-contact and thrust series ball bearings for precision instruments and mechanisms.

25. Paper Capacitors

Solar Mfg. Corp.—4-page illustrated bulletin No. SPD-110 presents full details of Solite aluminized paper capacitors for use in miniature electronic and radio equipment. They are designed for operating temperatures up to 85 C.

26. Self-Lubricating Bushings

Moccasin Bushing Co.—12 x 18-inch wall chart of engineering data, No. 429, and supplementary bulletin cover composition, properties and specification numbers of Moccasin bronzes. Also shown are various types of self-lubricating bushings of general purpose types. Principle of construction and other information are given.

27. Taps

Greenfield Tap & Die Corp.—16-page booklet entitled "Selecting the Right Tap for the Job" explains basic relationships between taps and screw threads and presents data and tables to aid in selection and ordering of correct taps.

28. Plastic Parts

Kurz-Kasch, Inc.—16-page illustrated booklet entitled "A Businessman's Guide to the Molding of Plastics" provides data on company's facilities, equipment and production capacity. Design, material selection, mold-making, molding and finishing are discussed.

29. Metal Castings

Advance Foundry Co. — 8-page illustrated booklet shows photographic exhibits of Strenes metal castings and dies. Hardness, toughness, density, temperability, acid resistance and magnetic qualities are described briefly.

30. Universal Joints

Curtis Universal Joint Co.—6-page illustrated folder entitled "Curtis Universal Joints" contains engineering data, conversion table, and efficiency and static torque curves on line of universal joints. Also included is 4-page folder containing drawings of universal joint templates for draftsmen and engineers.

31. Air Control Valves

Automatic Valve, Inc.—6-page illustrated catalog No. 47 discusses air control valves for control of single and double-acting cylinders. Valves are shown in diagrammatic form and ordering instructions and price list are given.

32. Patterns & Castings

Howard Foundry Co.—54-page illustrated brochure entitled "Castings and Patterns by Howard" deals with procedures involved in casting aluminum, magnesium, bronze, brass and semisteel. Also described are bronze fittings and lawn sprinkler heads and systems.

33. Technical Ceramics

American Lava Corp.—32-page illustrated bulletin No. 444 is descriptive of AlSiMag extruded, pressed and cast ceramic parts for application in electrical, mechanical, thermal and chemical industries. Chart listing mechanical and electrical properties of ceramics is included.

34. Roller Bearings

Bower Roller Bearing Co.—4-page illustrated folder discusses Spher-O-Honed roller bearings for use in automobiles, trucks, tractors, bulldozers, farm machinery, buses, jeeps and other transportation vehicles. Finish of bearings is refined to 3 microinches.

35. Small Gears

Gear Specialties—4-page illustrated bulletin No. 4a/11 discusses spurs, spirals, helicals, bevels and miters, internals, worm gearing racks, thread grinding, armature shafts, segments, ratchets and suggested applications. Facilities for milling; broaching; external, internal, surface and thread grinding; and polishing operations are described briefly.

36. Forged Steel Fittings

Ladish Drop Forge Co.—44-page illustrated engineering and technical data reference book Vol. 2 presents information covering all types, sizes and pressure ratings of fittings in company's line. Briefly described are forged steel flanges for steam, water, oil vapor, oil, gas and air; seamless welding fittings and drop forgings weighing up to 3200 pounds.

37. Protective Strip Coatings

Tennessee Eastman Corp.—4-page leaflet entitled "Protective Strip Coatings of Eastman Cellulose Acetate Butyrate" describes preparation and application of continuous, tough coatings for protection of metal parts against corrosion and abrasion in transit and storage.

38. Hydraulic Power Unit

Industrial Hydraulics Corp.—2-page illustrated data sheet presents design, engineering and performance data on model PH3B hand-operated hydraulic power system for snowplows, farm equipment, road machinery and general industrial use.

39. Snap Rings

Eaton Mfg. Co., Reliance Div.—6-page illustrated folder No. 43 contains data on standard snap, bearing, lock and retainer rings for bearings, housings and shafts. Illustrations show various cross-sections of all types of rings made from round, square and special shapes.

40. Alloy Steels

Carpenter Steel Co.—8-page illustrated booklet entitled "Two Steels Simplify Your Alloy Needs" gives descriptions, instructions for working, physical properties, standard stock sizes, tolerances and applications of No. 5-317 and No. 158 chrome-nickel alloy steels.

41. Ball Bearings

Boston Gear Works—6-page illustrated folder form No. 1-46 gives information on dimensions, tolerances and list prices of 1600 series Nice precision ball bearings.

42. Engines

Novo Engine Co.—12-page illustrated bulletin No. E-101 gives specifications, dimensions, features and general data on 1, 2 and 4-cylinder, water and air-cooled gasoline engines. Cutaway illustrations of various models are shown.

43. Hydraulic Cylinders

Logansport Machine Co. — 32-page illustrated catalog No. 84 describes Rotocast hydraulic cylinders for wide range of applications wherever power is required for pushing, pulling, lifting or holding operations. Cylinders for operating pressures up to 1500 pounds per square inch are available. Data on accessories, parts list, combination mountings, special cylinders and typical installations are given.

MACHINE DESIGN 5-47
1213 West Third St., Cleveland 13, Ohio

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2	12	22	32	42
3	13	23	33	43
4	14	24	34	44
5	15	25	35	45
6	16	26	36	46
7	17	27	37	47
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9	19	29	39	49
10	20	30	40	50

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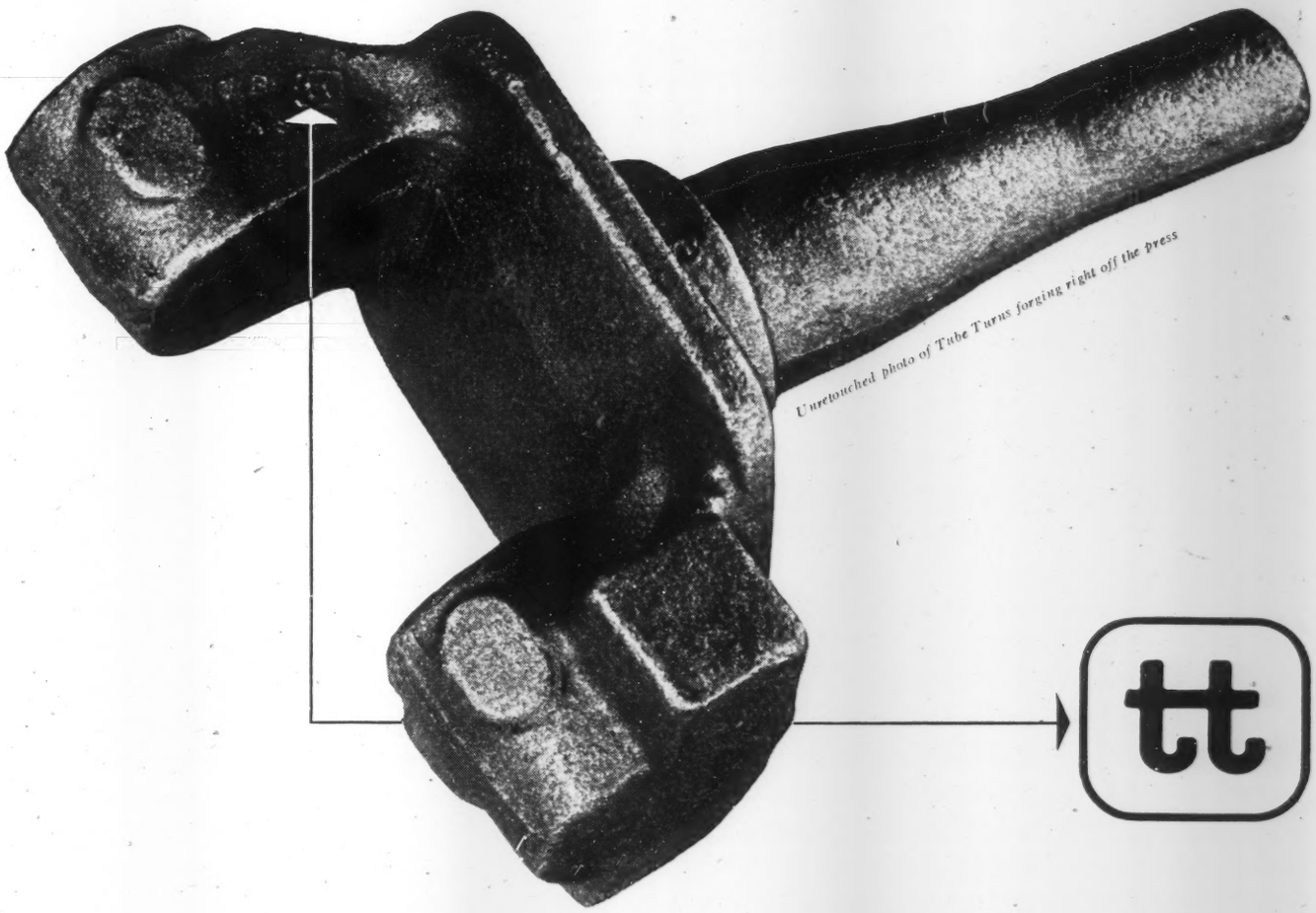

Unretouched photo of Tube Turns forging right off the press

Why sign a Forging?

The "tt" signature on every TUBE TURNS forging is the mark of a qualified forging.

It stands for a consistently sincere effort to do a really good job in mass-production quantities at the right price.

TUBE TURNS' progressive die designing, die making abilities and modern equipment give you forgings properly held to specified tolerances, with metal that has gone all the way out to the end of the dies, perfect flow lines and forged tensile strength throughout.

And the way in which TUBE TURNS facilities have been coordinated into a smoothly functioning system makes possible appreciable savings in forgings production cost. Every operation involved has been organized to keep pace with the speed of TUBE TURNS' high-speed mechanical presses and upsetters.

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District offices at New York, Washington, D. C., Philadelphia, Pittsburgh, Detroit, Chicago, Houston, San Francisco, Los Angeles.

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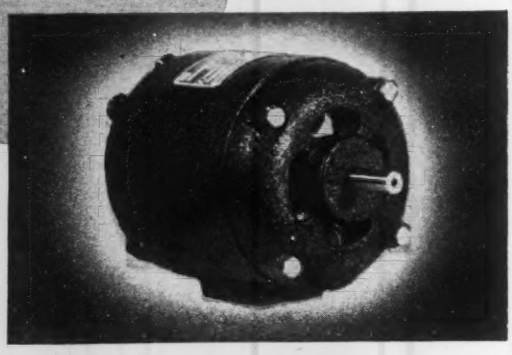


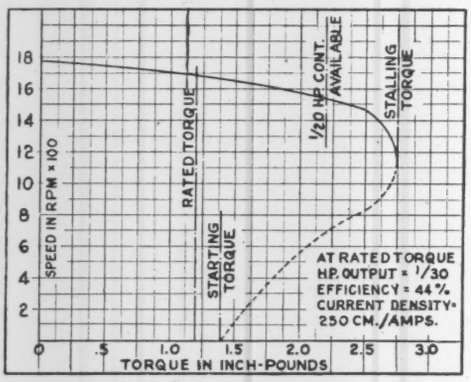
NEW TYPE "ALP"

CAPACITOR-TYPE MOTORS

Elinco sub-fractional horsepower motors are now available in the new "ALP" Frame, 3⅜" x 4$\frac{5}{16}$", as capacitor start and run, two and four-hole AC motors, internal fan cooled. As induction motor to 1/30 h.p. at 1700 r.p.m.; as synchronous motor to 1/60 h.p. at 1800 r.p.m. Substantially higher ratings are available at speeds of 3400 and 3600 r.p.m. respectively. Also, higher ratings for intermittent duty.

TYPICAL PERFORMANCE CURVE

For Type ALP-191, 110 volt 60 cycle single-phase Capacitor start and run; Motor Capacitor Value 4.25 Mfd. Curve #235.



HIGH-QUALITY PRECISION INSTRUMENT TYPE MOTORS AND GENERATORS EXCLUSIVELY

All motors and generators ball-bearing type; can be mounted in any position. Housings and end bells of cast aluminum; dynamically-balanced rotors; special finishes can be provided to meet varying conditions of climate and usage. Units ordered can be either standard or special models; different shaft diameters, lengths, or changes in dimensions, as well as alterations in electrical characteristics, can be specified. Design and engineering service available. The production of fine precision units to blueprints or specifications is our specialty.

Write for Temporary Bulletin 46-A

ELECTRIC INDICATOR CO.

STAMFORD U.S.A. CONN.

on new or old designs....

CHICAGO "*Safety Plus*" means *extra* holding power

Precision-made Chicago "Safety Plus" Products are the solution to many current production problems.

Exacting inspection standards insure sharp, full threads, uniform pitch diameter and clean true sockets. "Safety Plus" Products are manufactured from the finest selected heats of electric furnace alloy steel which provides added strength, toughness—and EXTRA holding power.

These outstanding features combine to make a truly fine product—ideally suited to modern production methods.

Chicago "SAFETY PLUS" line includes:

Socket Head Cap Screws • Socket Set Screws • Stripper Bolts • Square Head Dog Point Set Screws • Socket Pipe Plugs • Keys for "Safety Plus" Products.

Complete line includes:

Hexagon Head Cap Screws • Square Head Cup Point Set Screws • Headless Set Screws • Fillister Head Cap Screws • Flat Head Cap Screws • Taper Pins • Milled Studs • Semi-Finished Hexagon Nuts • Semi-Finished Hexagon Castellated Nuts.

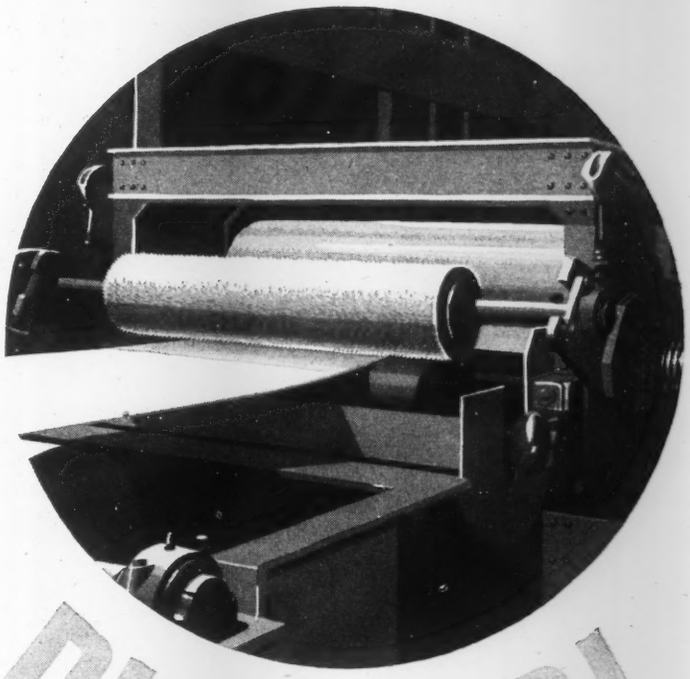
These Fine Products are sold only thru Authorized Distributors

THE CHICAGO SCREW CO.

ESTABLISHED 1872

1026 So. Homan Avenue Chicago 24, Ill.

Pickled steel gets a PICK-UP!



● Stainless steel sheets pickled in nitric and sulphuric acid baths must be finished off with a hot water scrubbing. That calls for a tough brush . . . and Pittsburgh Brushes get the call from all important strip steel producers. ● Many brushes wilt quickly when contact is made with hot water-sprayed steel sheets, but Pittsburgh's dense fill of white tampico and Bahia fibre mixture, spiral wound and evenly trimed, stands up under the heaviest punishment. Fine stainless steel wire wound mandrels are also available.

Why the Pittsburgh Plate Glass Company Makes Brushes

As a leading manufacturer of paints, Pittsburgh found that a reliable source of quality brushes was necessary for the proper application of its products. For over 40 years, Pittsburgh has made its own paint brushes. It was a natural step to extend its engineering and manufacturing facilities by developing production, maintenance and power-driven brushes engineered to the specific needs of industry.

Back the All-American "Scrub Team" of Pittsburgh Brushes

● A Pittsburgh Brush does the job fast and gives you a uniformly finished product. You can depend on Pittsburgh Brushes for better performance, enduring economy, and a minimum of lost time in changeovers. In the complete Pittsburgh line are brushes of all types, including "Perfect Balance" sections, wheels and section assemblies, Uni-Fill scratch brushes, as well as paint and other maintenance brushes. ● Consult with the Pittsburgh engineering representative. He will gladly work with you in developing any type of power-driven brushes to meet your particular finishing requirements.

PITTSBURGH
PLATE GLASS COMPANY *Brush Division*
3221 FREDERICK AVENUE · BALTIMORE—29 · MARYLAND

What Would You Do About A Problem Such As This?

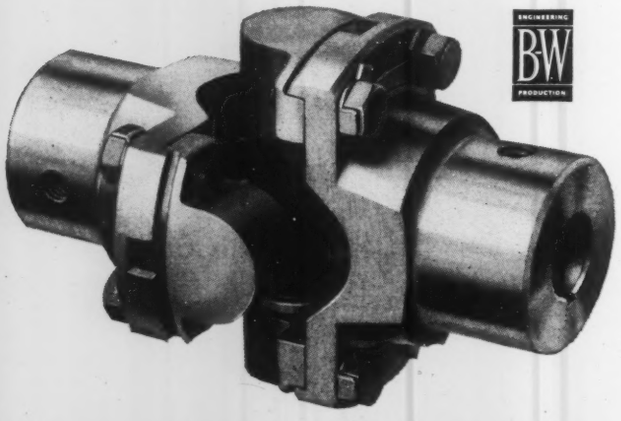
INTER-OFFICE MEMO:
Let's design our 194X model so that it will need less "greasing" attention.

MECHANICS design permits generous, long-lasting lubrication — without disassembling. One "shot" through a convenient oil plug hole in the cross fills the reservoir from which lubricant is forced to all four bearings.

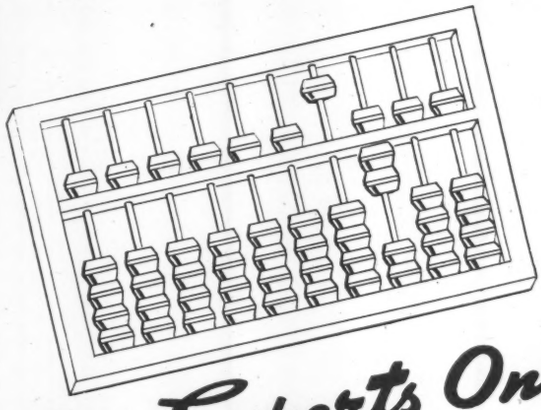
Another "shot" fills the slip-yoke chamber.

Efficient seals prevent leakage and keep out dirt and moisture.

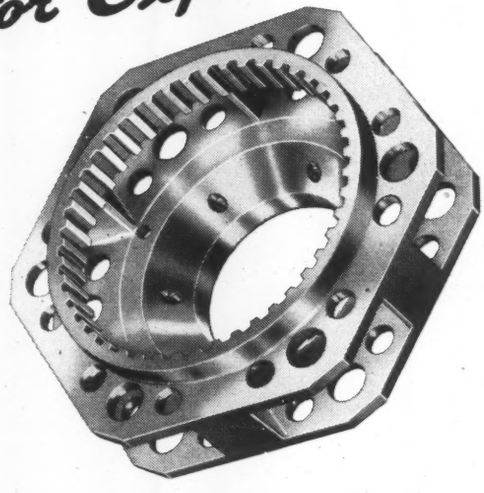
Let our engineers show you how this and other MECHANICS advantages will benefit your new models.



MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2026 Harrison Ave., Rockford, Ill.



For Experts Only



• Yes, they have a common bond, these two—they are for experts only. The abacus is the Chinese equivalent of our modern calculating machine *but only* in the hands of an experienced operator . . . the exceptionally close tolerances* and precision qualities of the planetary spider can *only* be produced by experienced personnel using the finest in equipment and the best in production methods.

*In this typical IGW job the various holes have a .0004 total limit on diameter and .0005 total limit on spacing. The internal gear has a maximum allowable index error of .0002.

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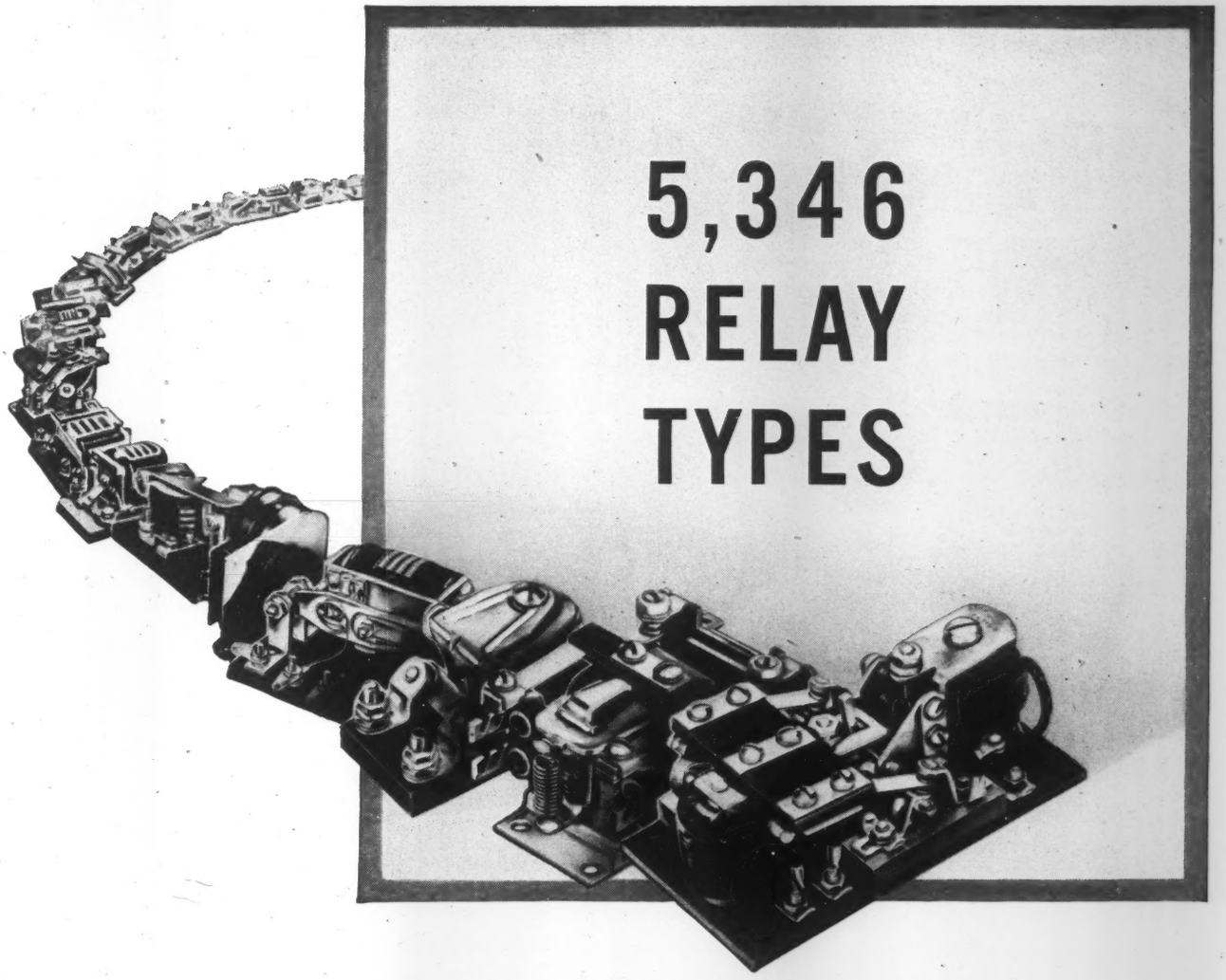

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Each adaptable to many coil and contact arrangements to fit your individual needs.

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Welco Collector Rings are custom-built to fit the special design and functional requirements of your machines or equipment. A limited number of standard types are available. Send us your blueprints and we will design for you the collector rings that are functionally correct.

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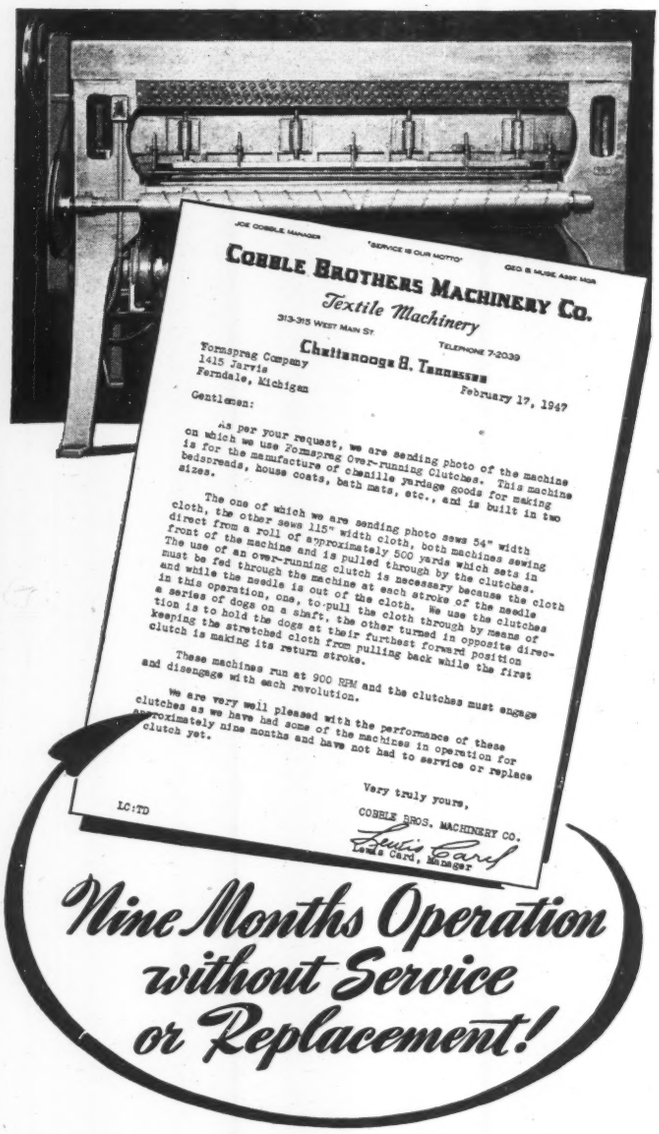

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Formsprag Clutches deliver high torque under severe space limitations. They are accurate, positive, efficient. They are delivering trouble-free performance in many different types of work.

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THE FULL COMPLEMENT
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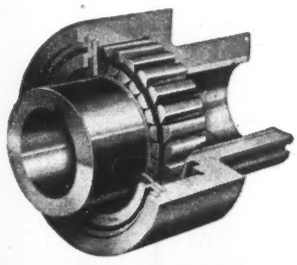
There are many standard sizes on which we are making good delivery. Perhaps one of these will meet your requirements. A letter, or phone call—Detroit, PLaza 6640—will bring you full information.



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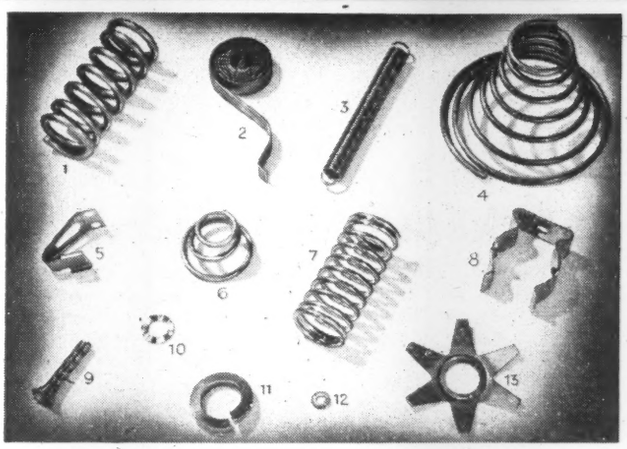
"ELEPHANT BRAND" PHOSPHOR BRONZE

. . . an Ideal metal for Springs



1. Compression Spring; 2. Torsion Spring; 3. Extension Spring; 4. Involute Spring; 5. Spring Contact; 6. Involute Spring; 7. Compression Spring; 8. Fuse Clip; 9. Extension Spring; 10. Spring Washer; 11. Lock Washer; 12. Lock Washer; 13. Spring Washer.

Yes, because of its ability to withstand frequent "stress reversals," Elephant Brand Phosphor Bronze is really an "ideal" alloy for Springs, Expansion Bellows, Diaphragms, etc. Of course, its other well known and proven qualities are: Corrosion Resistance, Strength, Fatigue Resistance, Easy Workability, Low Friction Coefficient, Resistance to breakdown under arcing, an excellent Electrical Conductor, and Non-magnetic properties — so, may we suggest that you look into the great advantages of "Elephant Brand," the *Pioneer Phosphor Bronze*. Send for the *Handbook* mentioned below.

Send for this Technical Booklet

This handbook gives in simple form: where and how to use Phosphor Bronze—and how to choose the alloy best suited for your purpose. You'll find it authoritative, complete and a great help in your work. Your request for a copy entails no obligation.

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The Phosphor Bronze Smelting Co.

Original Manufacturers of Phosphor Bronze in U. S. A. Established 1874

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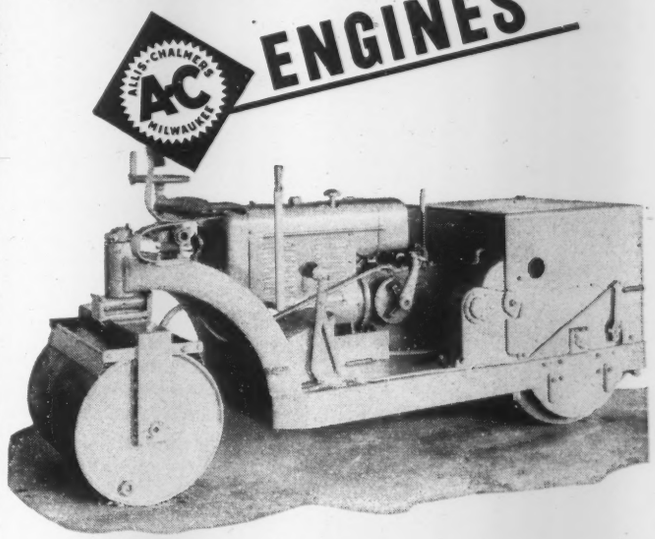
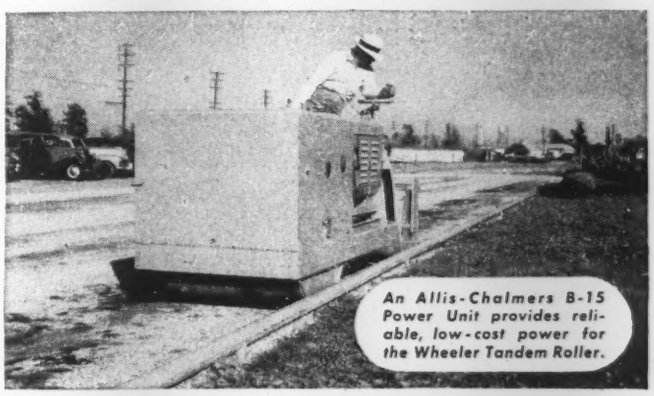
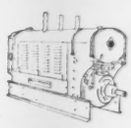
NEW WHEELER TANDEM ROLLERS ARE POWERED BY ENGINES



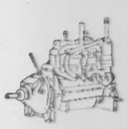
Wheeler Tandem Rollers join the long list of products powered by Allis-Chalmers Engines. Designed for tough tractor service, high in torque, these rugged Power Units maintain a constant speed for steady, smooth performance, with minimum regulation. Five models to choose from. Various accessories to fit the application. Choice of fuels. Nation-wide service facilities. Our power engineers will gladly help select the correct unit to fill your requirements.



An Allis-Chalmers B-15 Power Unit provides reliable, low-cost power for the Wheeler Tandem Roller.



POWER UNITS Five Sizes



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Model B-15	4 Cyl.,	24 Max. B.HP. at 1500 R.P.M.
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Model E-60	4 Cyl.,	74 Max. B.HP. at 1050 R.P.M.
Model L-90	6 Cyl.,	110 Max. B.HP. at 1050 R.P.M.

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Soft Metals, up to 2½" diam. x 3" long — any pitch.
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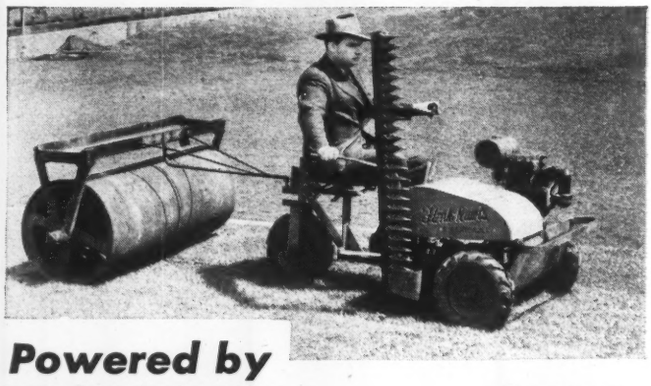

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In designing this unique piece of equipment which cuts, mows, grades, plows, hauls, rolls and sweeps . . . all with one machine and the various attachments with which it may be equipped . . . the Flink Company, of Streator, Ill., selected a 4-cycle, 4 hp. Wisconsin Air-Cooled Engine as the most satisfactory power unit from all standpoints.

A Wisconsin Engine on *any* machine is the best possible guarantee of operating economy, heavy-duty serviceability, trouble-free cooling and quick, easy starting in any weather, in any climate. Specify Wisconsin Engines for *your* equipment for utmost adaptability to your requirements. Single and 4-cylinder models, in a full range of sizes from 2 to 30 hp.

WISCONSIN MOTOR Corporation
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WORLD'S LARGEST BUILDERS OF HEAVY-DUTY AIR-COOLED ENGINES

A GOOD PLACE TO TAKE YOUR PUMPING PROBLEMS

It's a good idea to take your rotary pumping problems to the leader in the field . . . Viking Pump Company. Here, your problem will be solved, based on the experience of many others . . . and with a choice of pumps from a complete range of models and sizes. There is no sacrificing the right pump for your job because of a short line of rotary pumps. In addition, a complete sales and engineering service is available at many principal cities. Direct factory offices and outstanding, well-informed representatives are ready to serve you. Weigh the facts before making your decision. Write today for folder 46SH and ask for complete recommendations on your pumping problem.

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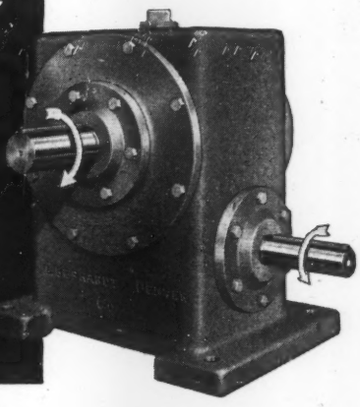
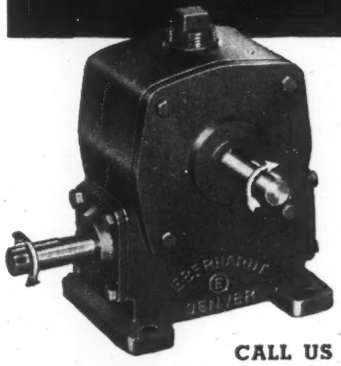
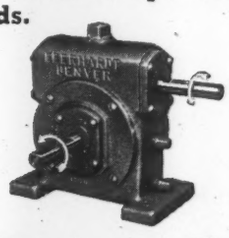
Producers of Time-Tested Quality Instruments

Speed Reducers **FROM STOCK**





Manufactured in a practical range of sizes and reductions. We also build reducers to meet special needs.



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GEARS AND SPEED REDUCERS
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and

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Look at this one SPEED NUT that does *three* jobs. Conceived by our engineers to simplify parking lamp assembly, it retains light socket, spaces wires and fastens entire assembly to the base. (See sketch.) It replaced four parts and eliminated three operations. This is typical of the SPEED NUT Savings Factor. So flexible is the basic SPEED NUT principle, it can be incorporated in almost any shape to improve your product, speed up assembly, reduce the number of parts and cut costs. We can give you a no-charge fastening analysis that may surprise you. Send in your assembly details today.

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FASTEST THING IN FASTENINGS

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on the plan that delivers Peace of Mind

THANKS to the work of patriotic volunteers, the U. S. Savings Bonds program has carried America a long way up the road to economic security.

During 1946, in spite of all the problems and uncertainties the nation faced, sales of Savings Bonds *exceeded redemptions* by $1,389,216,000. The success of this great sales operation has helped stem the tide of inflation, has reduced public debt holdings of the banking system, and has given millions of citizens a stake in their country and a profitable investment in their own futures.

Yes, we've come a long way—but the trip isn't over! Now is the time to check up on your Payroll Savings Plan. Make sure that all your new employees are familiar with its advantages. Remind *all* your employees that there's no easier, surer way to build their own futures—and America's—than by buying Bonds regularly through the Payroll Savings Plan. Every $3 invested pays $4 at maturity!

For any help you need in conducting the Payroll Plan, call on your State Director of the Treasury Department's Savings Bonds Division.

New Savings Bonds Plan won't affect the P.S.P.

SOON the Treasury Department and the banks of America will make it possible for farmers, doctors, and other self-employed people to participate in "automatic" Bond buying by special arrangement with their banks. This extension of the Savings Bonds program is not a partial payment plan and is intended *only* for people who are not in a position to take advantage of the Payroll Savings Plan.

The Treasury Department acknowledges with appreciation the publication of this message by

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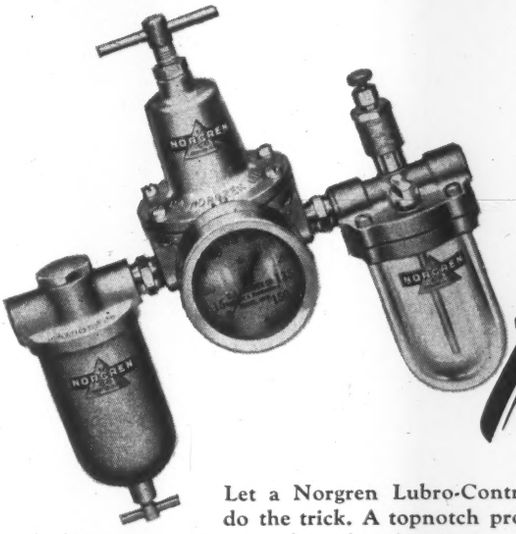

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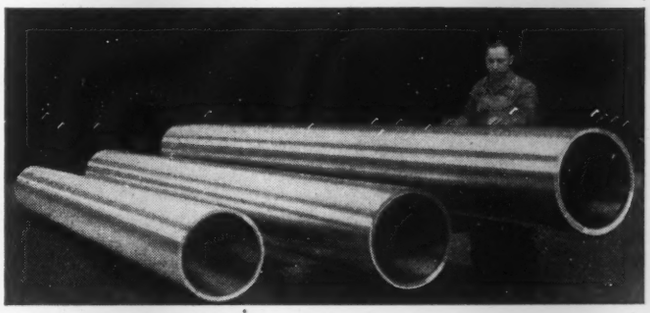

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AMERICAN

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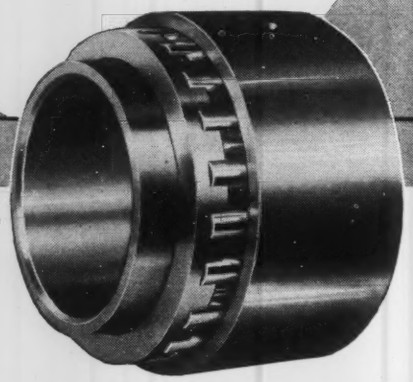

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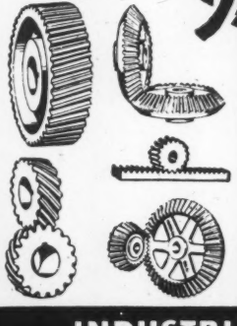

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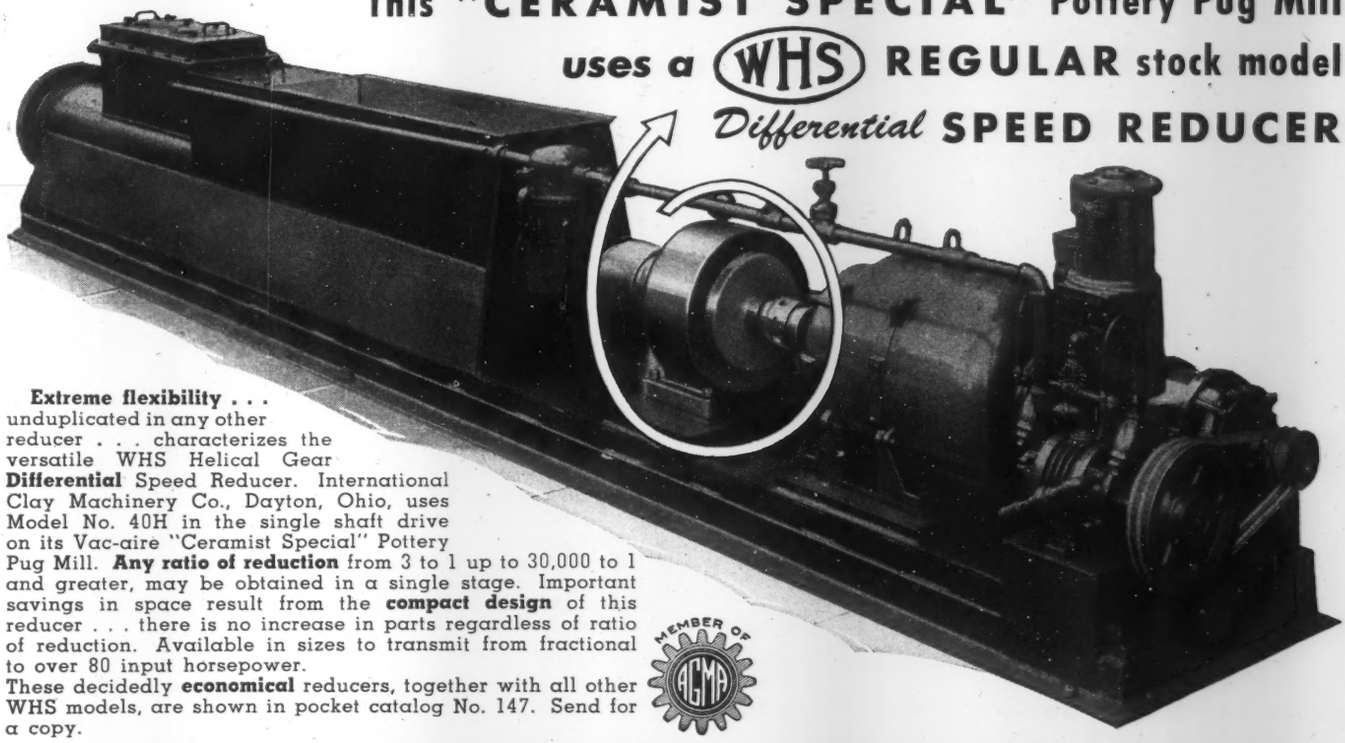

Extreme flexibility . . . unduplicated in any other reducer . . . characterizes the versatile WHS Helical Gear **Differential** Speed Reducer. International Clay Machinery Co., Dayton, Ohio, uses Model No. 40H in the single shaft drive on its Vac-aire "Ceramist Special" Pottery Pug Mill. **Any ratio of reduction** from 3 to 1 up to 30,000 to 1 and greater, may be obtained in a single stage. Important savings in space result from the **compact design** of this reducer . . . there is no increase in parts regardless of ratio of reduction. Available in sizes to transmit from fractional to over 80 input horsepower.

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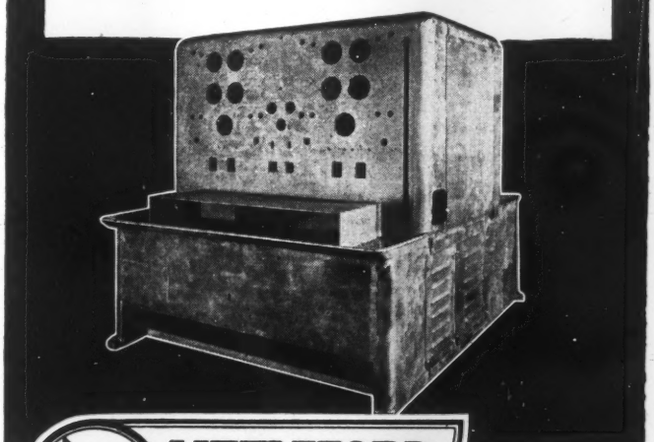

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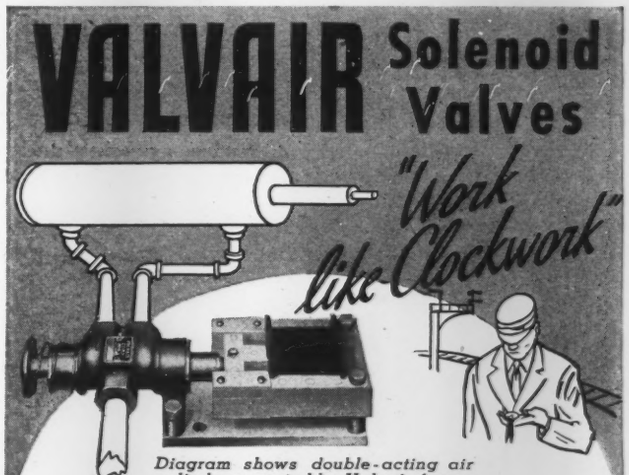

Diagram shows double-acting air cylinder operated by Valvair 4-way solenoid valve, spring return.

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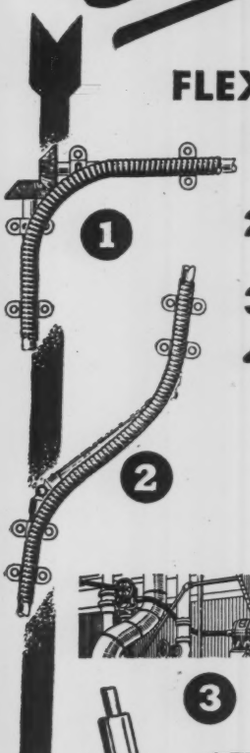

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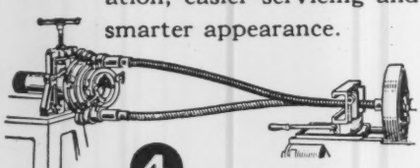

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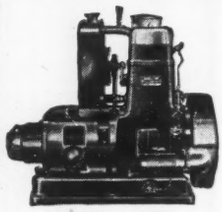

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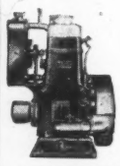

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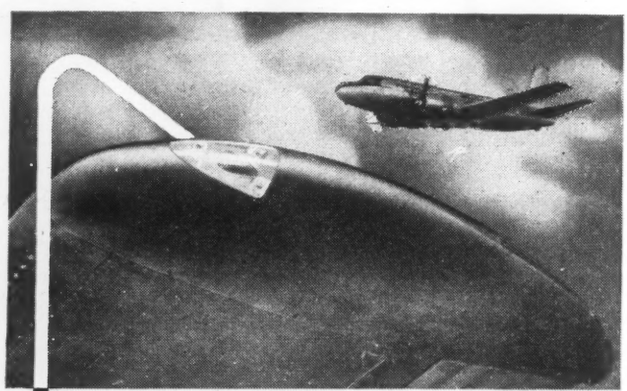

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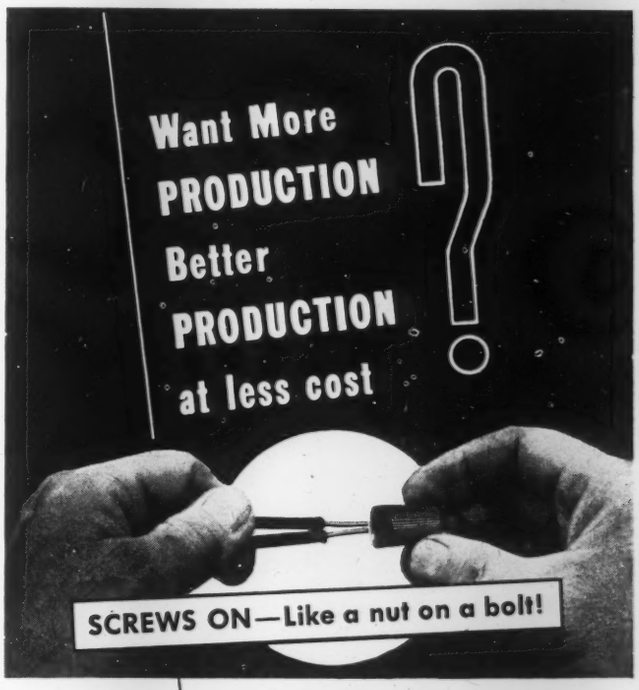

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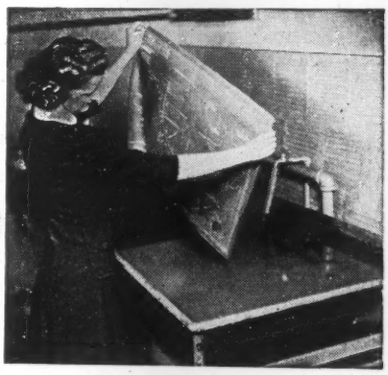

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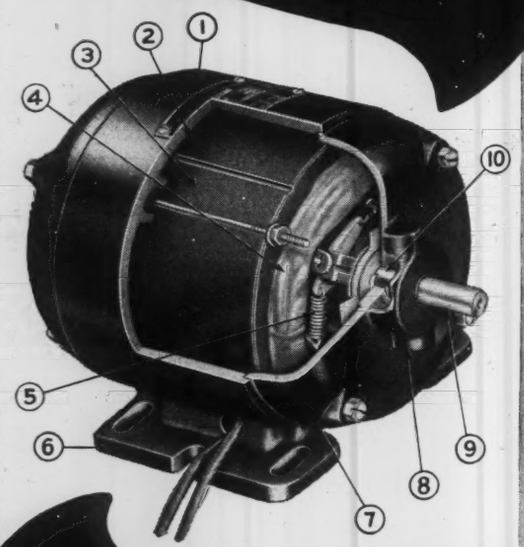

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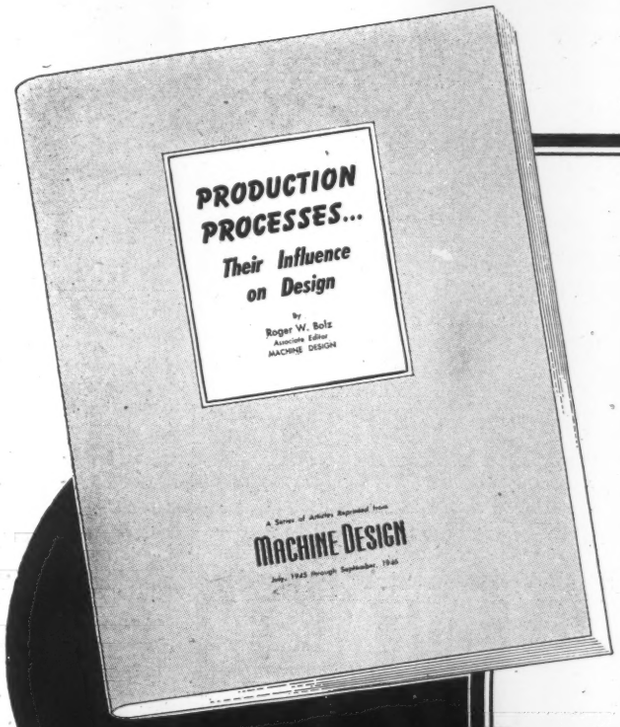

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Associate Editor, MACHINE DESIGN

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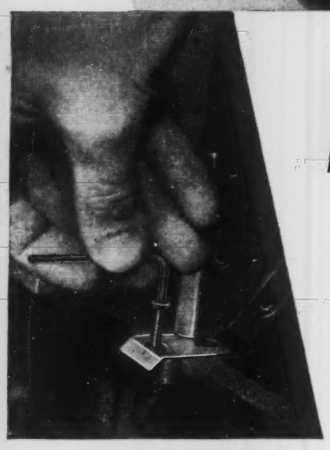

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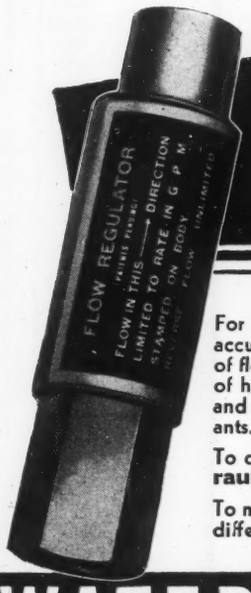

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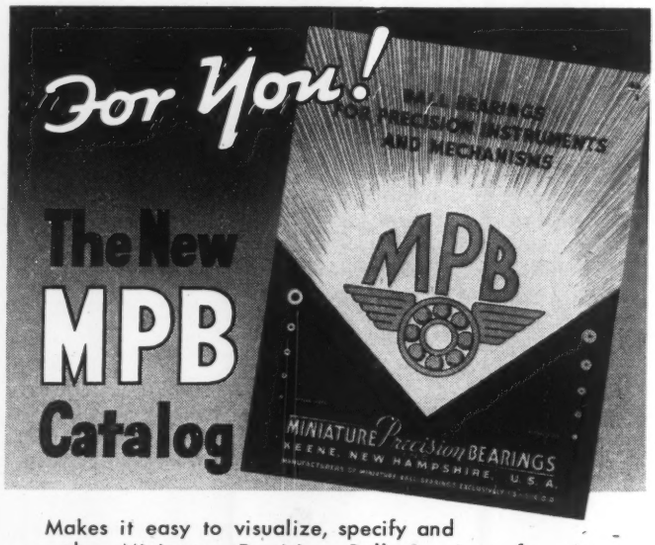

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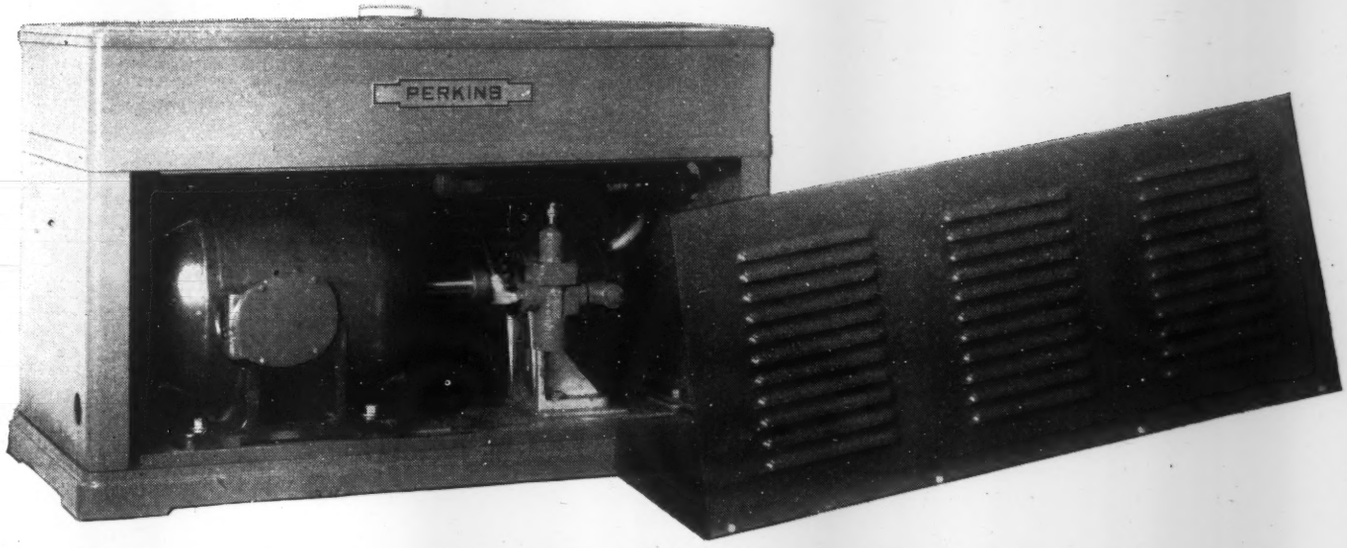

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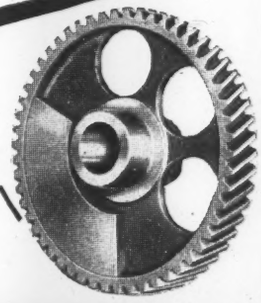

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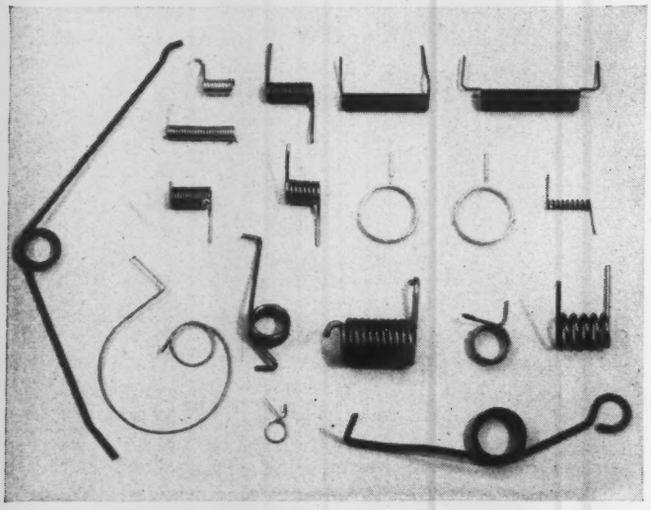

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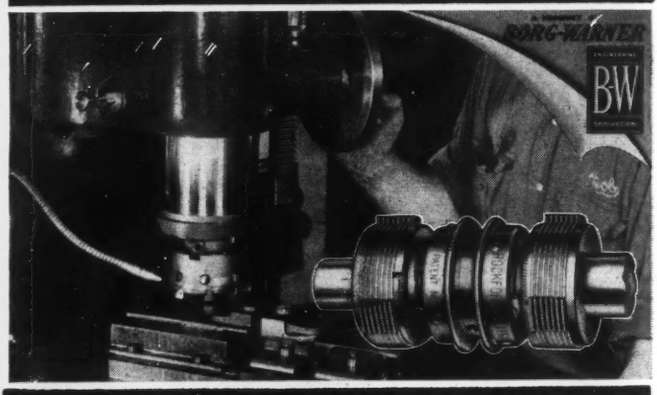

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COMPACT DESIGN
HIGH TORQUE
HIGH-RATIO LEVERS
POSITIVE NEUTRAL
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LONG WEAR LIFE *
EASY ADJUSTMENT

* Heat-treated alloy steel provides wear-resisting bearing surfaces that are machined to close tolerances. The shifter spool has a deep slot, hardened and ground, which prolongs clutch life and reduces shifter fork wear. Discs have flat, true surfaces, free from high or low spots. Thus operating conditions remain uniform, even after long service.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD CLUTCH DIVISION BORG-WARNER
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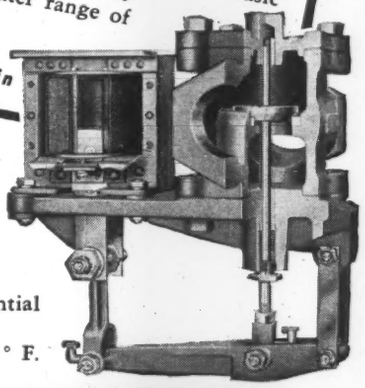

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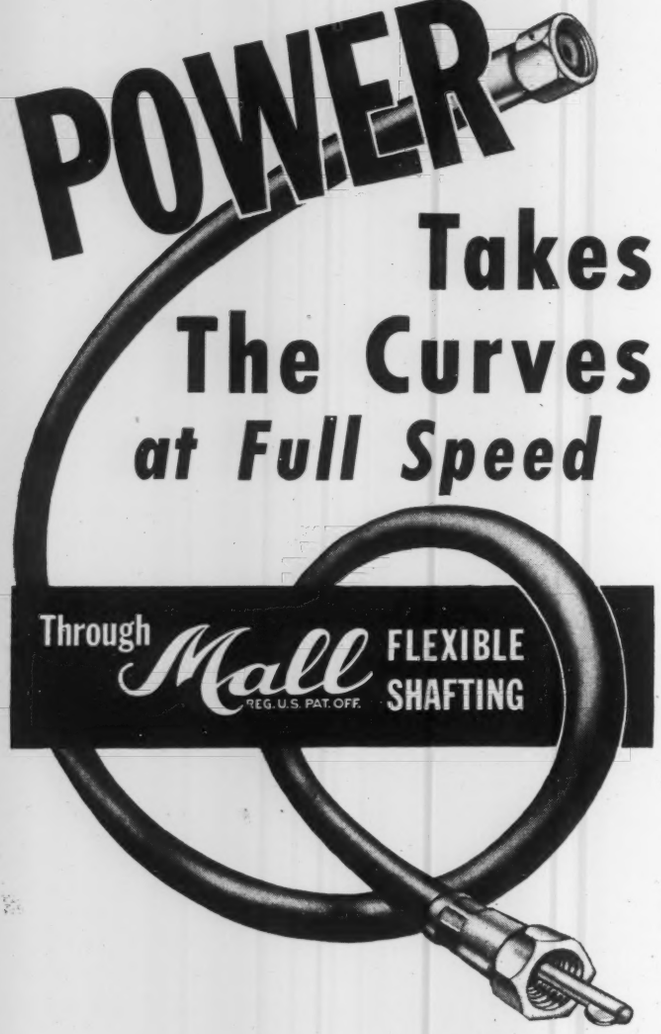

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MALL TOOL COMPANY

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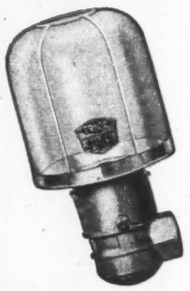

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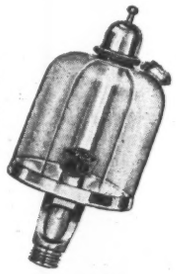

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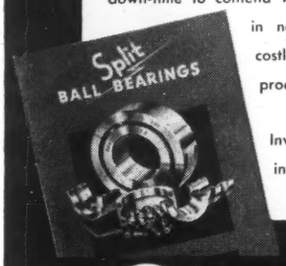

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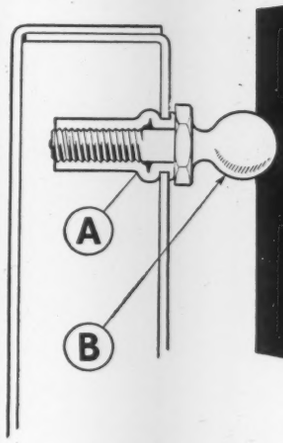

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Designers needed a rivet that 1) could be installed from one side only, 2) would serve as a nutplate for a knob attachment and 3) could be installed *after* enameling. A Rivnut proved the perfect answer.

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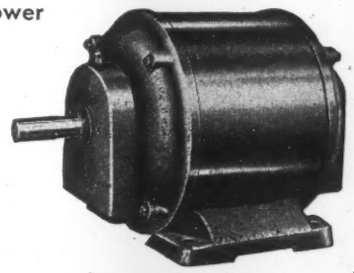

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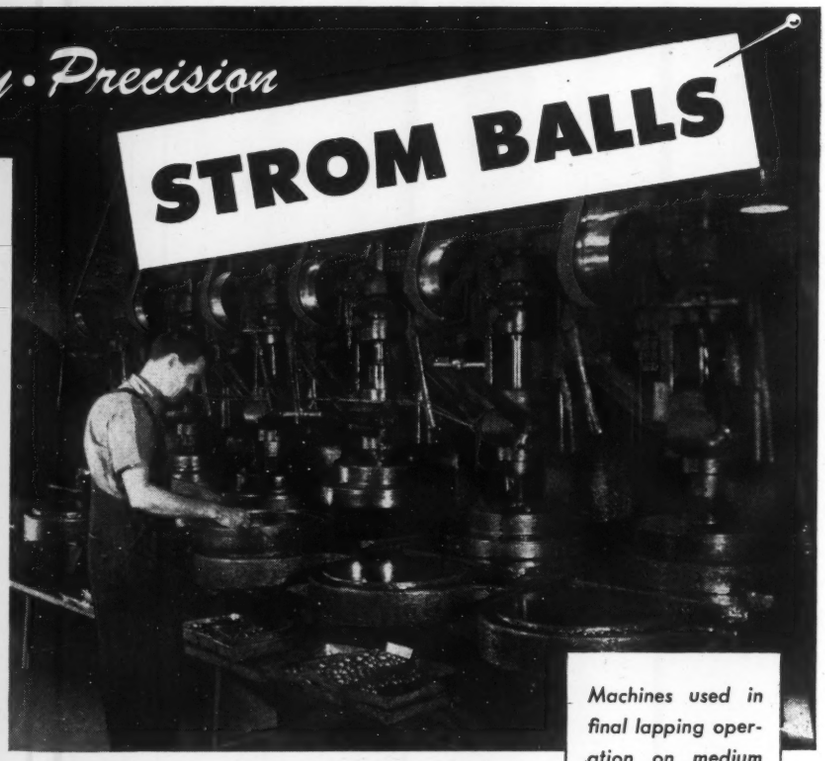

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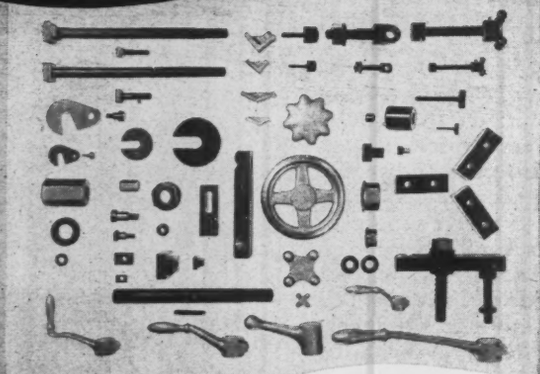

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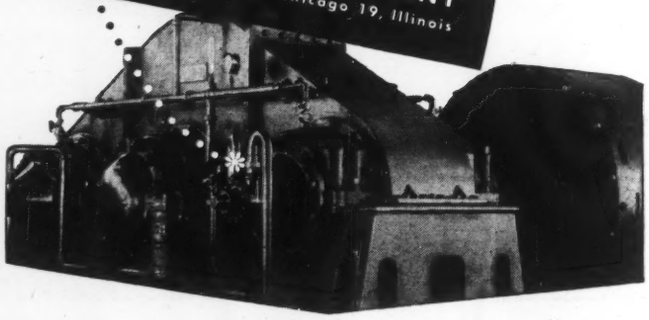

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A new series of Plugs and Sockets designed for highest electrical and mechanical efficiency. Improved Socket Contacts provide 4 individual flexing surfaces which make positive contact over practically their entire length. The Contacts on both Plugs and Sockets are mounted in recessed pockets g r e a t l y increasing leakage distance, thereby increasing voltage rating. Insulation is of BM 120 molded Bakelite.

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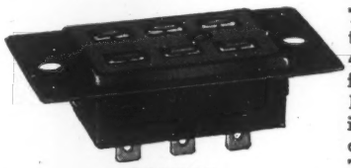

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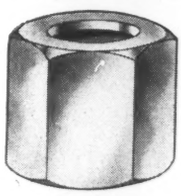

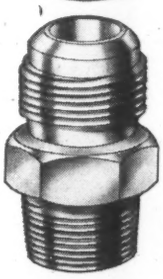

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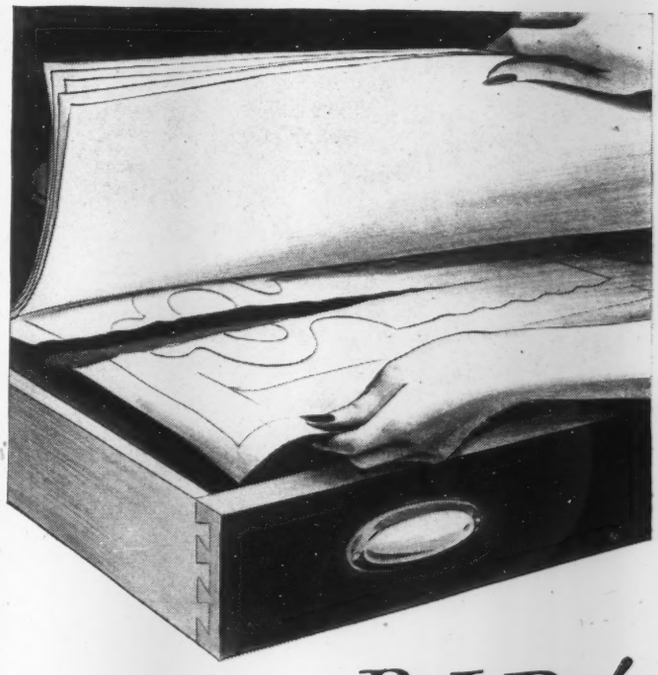

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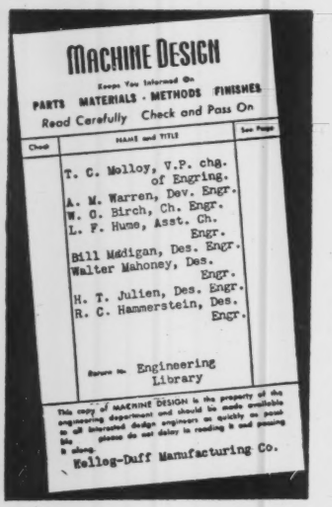
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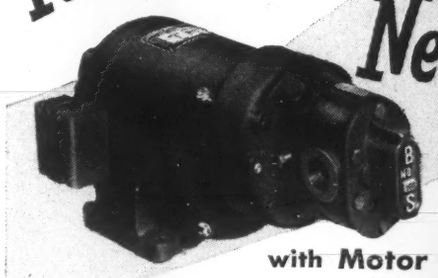

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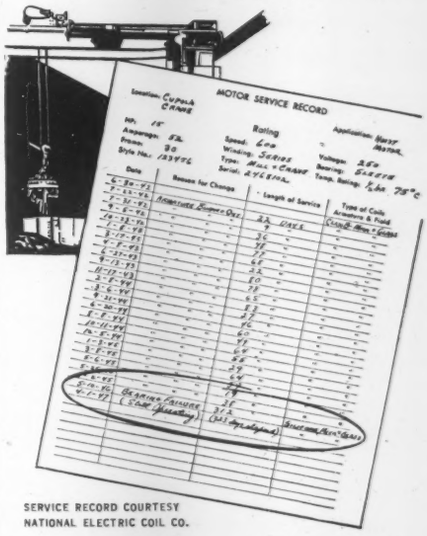
DC SILICONES

DC Silicone Insulation CUTS MOTOR FAILURE 90%!



SERVICE RECORD COURTESY NATIONAL ELECTRIC COIL CO.

A cupola crane motor used to unload scrap in a large steel mill was designed for intermittent service. But steel hungry America kept it working full time to meet war and postwar requirements. Insulated with the best Class 'B' materials, this motor failed 22 times in about three years, giving an average service life of only 50 days.

Design limitations made it impossible to install a larger motor. Lost time, costly rewinding, and heavy maintenance expense seemed inescapable—until DC Silicone Insulation was introduced by Dow Corning.

National Electric Coil Co., of Columbus, Ohio, was one of the first to realize the advantages of Silicone-glass-mica insulation. Their engineers redesigned the coils of that motor using Silicone Insulation—DC 996 Varnish with glass and mica.

Then it operated almost continuously for 312 days—six times the average life with Class 'B' insulation—before a bearing failed, causing mechanical failure of the insulation. The motor was again rewound with Silicone Insulation and was still running April 1, 1947—after 323 days!

DC Silicone Insulation will keep hard-working motors running at least 10 times as long as Class 'B' insulation. That's proved by three years of tough tests and field service. DC 996 is further described in leaflet No. B 3-7.

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*Trade Mark Dow Corning Corporation

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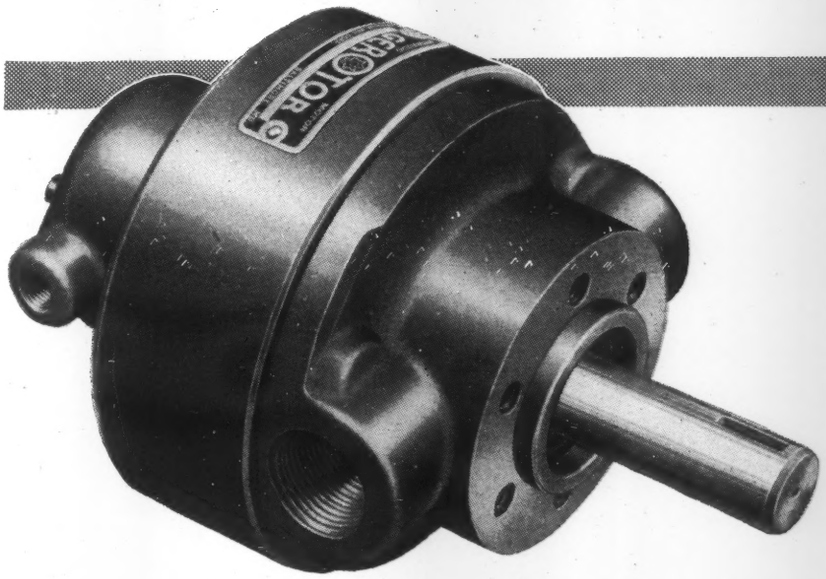

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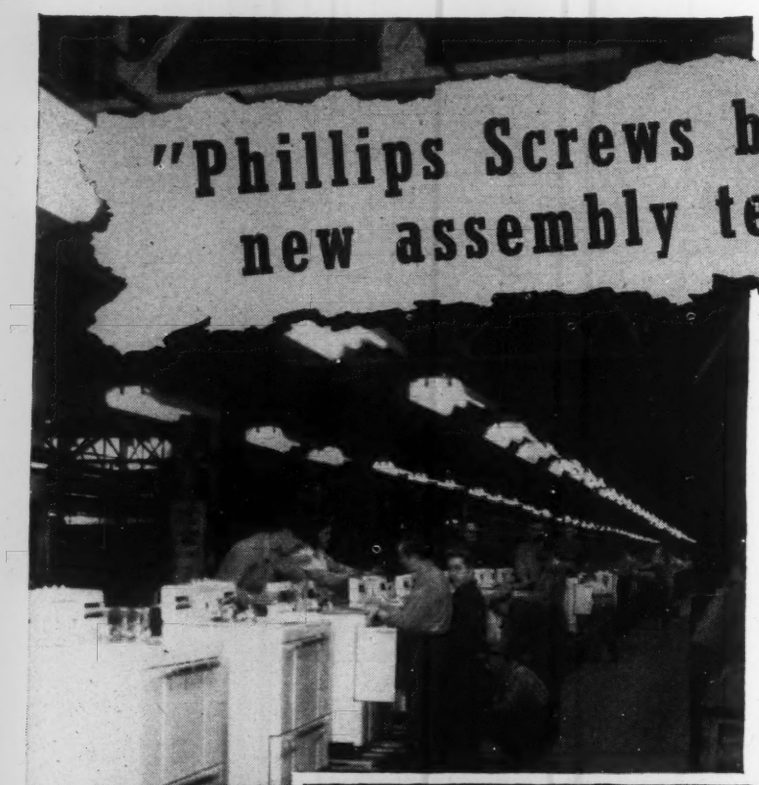
Highlights of an interesting report by the independent investigator of the James O. Peck Co. . . . another in their series of studies of assembly savings made with Phillips Recessed Head Screws.

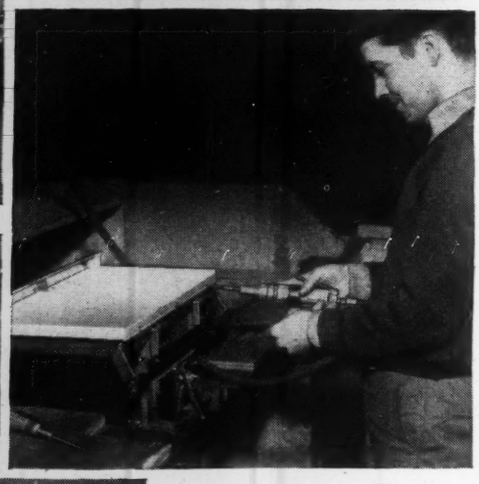
"We are 100% sold on Phillips Screws," the Works Manager of Globe American said, "because they fit right into our plans for the most efficient production methods in manufacturing our Dutch Oven Gas Ranges.

"Easier To Power-Drive. The Phillips Recessed Head is perfect for the air tools we're using in our assembly. They're practically *geared* to the tool so they start faster and drive easier.

"Simplify Awkward Applications. In the sub-assemblies and the final assembly many of the Phillips Screws used in each stove have to be driven from an angle . . . putting on door handles, driving under a ridge and some 'blind' driving. Most of these applications would be difficult or impossible with slotted screws, but are simple with Phillips Screws because of the snug fit of driver bit in the recess. Even when the driver is at an angle, they can be set up tight.

"No Gouging of Enamel. A lot of these screws are used close to the enamel finish of the stove. A regular slotted head driver would jump out of the screw head and scratch the work often enough to make the cost of consequent disassembly, refinishing and reassembly a serious factor. This can't happen with Phillips Screws."

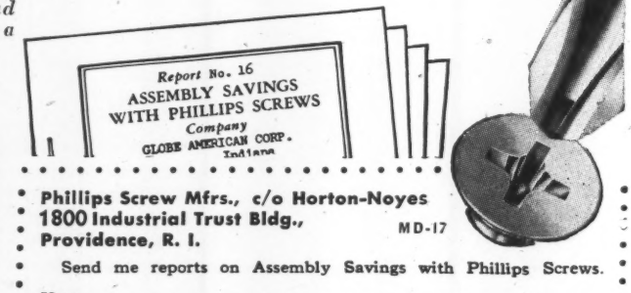




One of the many sub-assemblies of the Dutch Oven Ranges which illustrates the hazards to enamel finishes if slotted screws were used.

Straight-on or angled, the Phillips Recessed Head permits a fast start and a safe finish.

You'll Find Good Ideas for your assembly in this and other reports of assembly studies . . . covering metal, wood and plastic products. Use coupon.



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Wood Screws • Machine Screws • Self-tapping Screws • Stove Bolts

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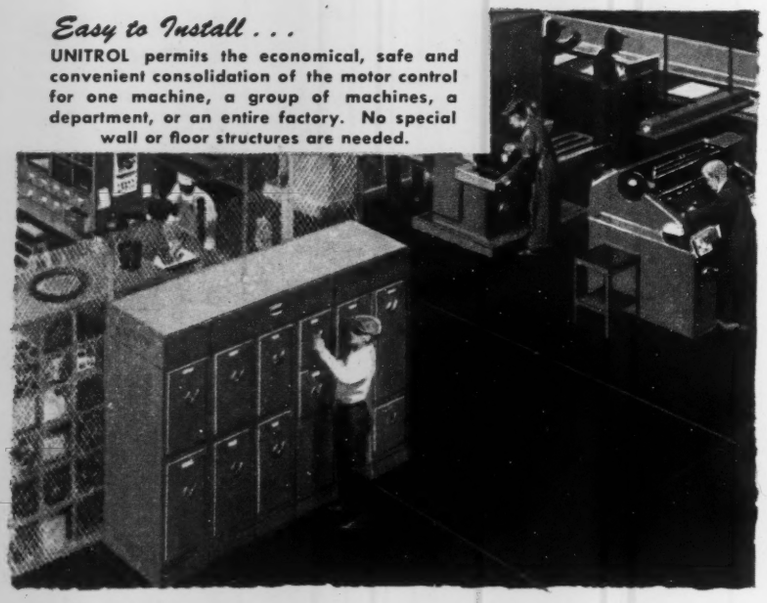

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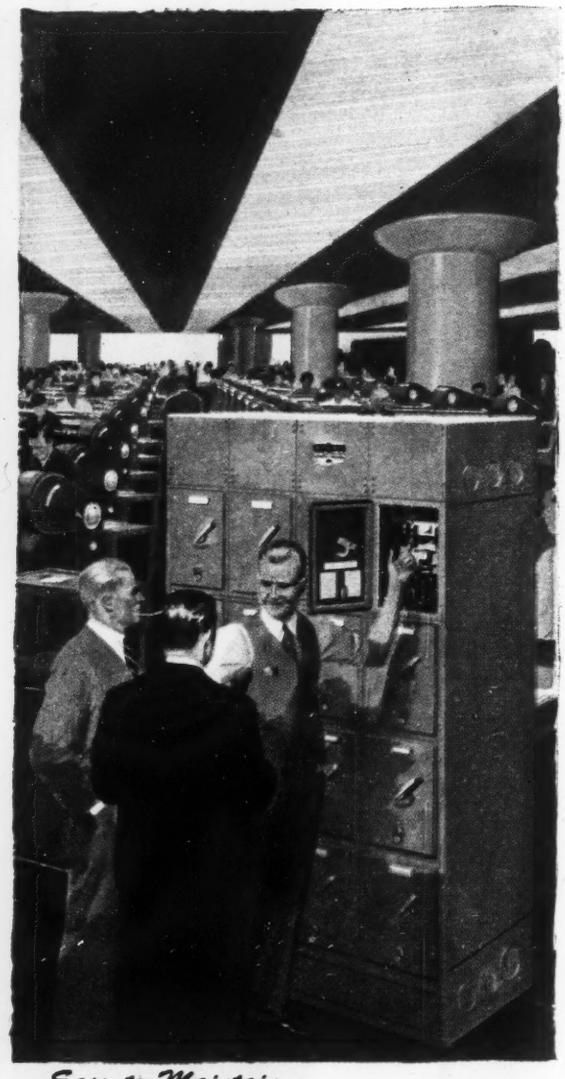

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